Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

1010 EMPIRE BUILDING | SEPTEMBER, 1946 | PITTSBURGH, PENNSYLVANIA

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DETROIT

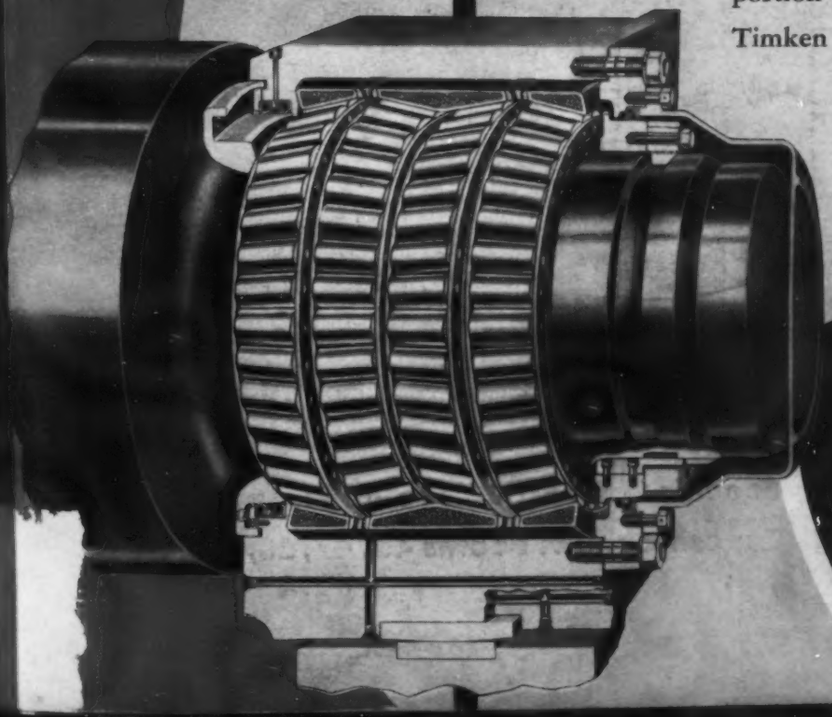
now

you can have roller bearing efficiency with bigger, stronger mill roll necks

The development of the Timken Roll Neck Bearing over 20 years ago brought to rolling mill operators an entirely new conception of mill efficiency. Rolling speeds went up; roll neck bearing costs went down; involuntary production interruptions became fewer and fewer; mill tonnages increased.

Today, Timken Balanced Proportion Roll Neck Bearings, latest product of Timken engineering and metallurgical knowledge and experience, are successfully meeting the demand for heavier, more rigid mills and closer rolling tolerances by making possible larger diameter, stronger roll necks.

Thus you now can have the efficiency and simplicity of the roller bearing (which have never been surpassed) without any sacrifice of roll neck strength. Specify Timken Balanced Proportion Roll Neck Bearings for your new mills. The Timken Roller Bearing Company, Canton 6, Ohio.



TIMKEN

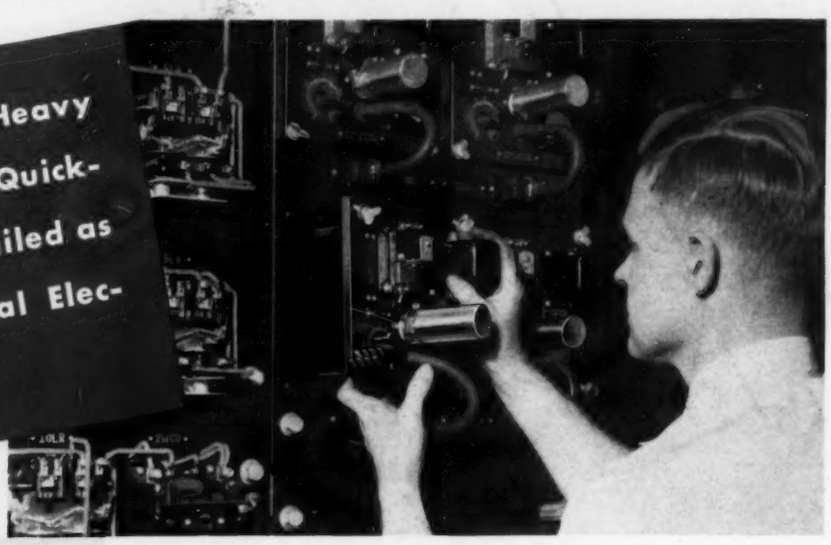
TRADE-MARK REG. U. S. PAT. OFF.

ROLL NECK BEARINGS

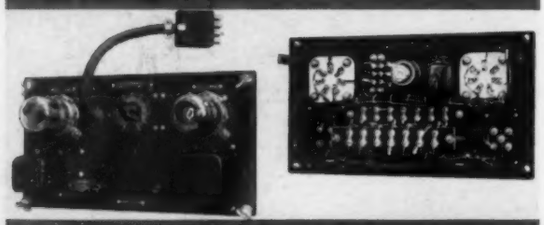
See us at the Iron and Steel Exposition, Cleveland Spaces 105 and 106

Now . . . *Electronics to Mill Standards*

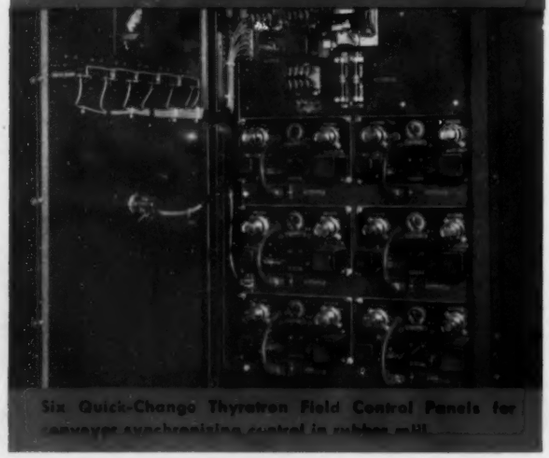
New Cutler-Hammer Heavy Duty Construction and Quick-Change Unit Panel Hailed as Outstanding Industrial Electronics Contribution.



C-H Supervisory Electronic Quick-Change Units on Enameling Furnace Control Panel. Here C-H Magnetic and Electronic Control is engineered to achieve the full practical advantages of both.



From one basic C-H Quick-Change Unit Panel, three simplicity, ruggedness, wiring, spacing. Also screw terminals, wing nut mounting, plug-in connector.



Six Quick-Change Thyratron Field Control Panels for conveyor synchronizing control in rubber mill.

To the public, industrial electronics is a miracle maker. To many a mill's electrical department its practical application now becomes a reality.

Equipment has been fragile and complex . . . tough to install and remove, to test and inspect.

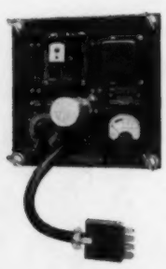
The Cutler-Hammer answer to mill duty electronics is a development now almost four years old, hailed by leading industrials as an outstanding contribution to practical electronics.

First of all, Cutler-Hammer engineers took electronic control equipment out of the radio receiver class and built it up to heavy duty industrial standards. Components are simple and rugged, minimum in number, better spaced, better wired and designed expressly for easy renewal of parts.

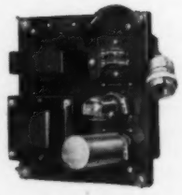
The introduction of the C-H Quick-Change Unit Panel now safeguards continuous mill operation plus other important advantages. Components are now mounted as a unit on a removable panel, assembled to the control board by means of captive wing nuts with plug-in connector. Inspection and instrument testing, back at the service bench is convenient because removing one electronic control panel and substituting a "spare" in its place is the matter of a moment.

These sane and sound solutions are another product of Cutler-Hammer's "electronics-in-industry" experience dating back to 1916. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wis. *Associate*: Canadian Cutler-Hammer, Ltd., Toronto, Ont.

CUTLER-HAMMER
ELECTRONICS
C-H



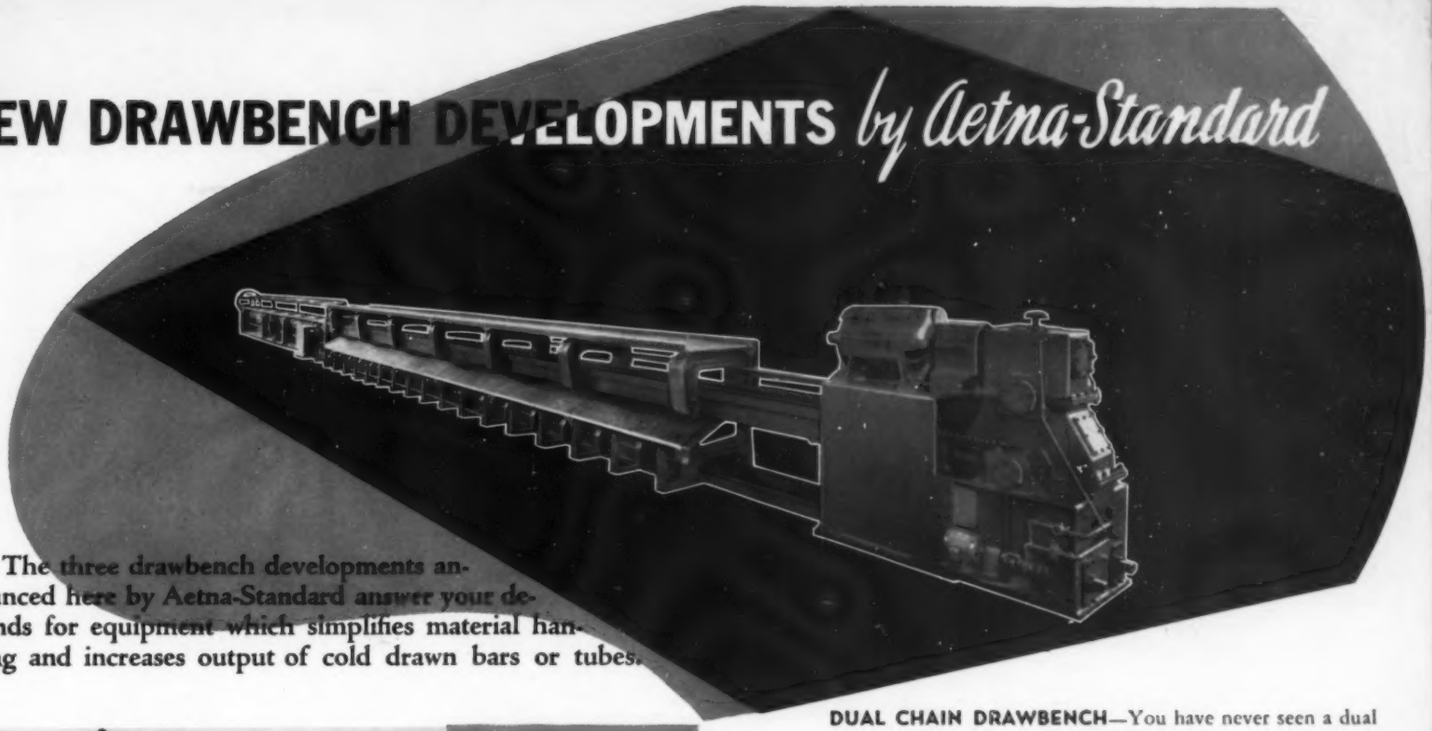
(at left) Typical C-H Mill Type Quick-Change Unit Panel for Furnace Control.



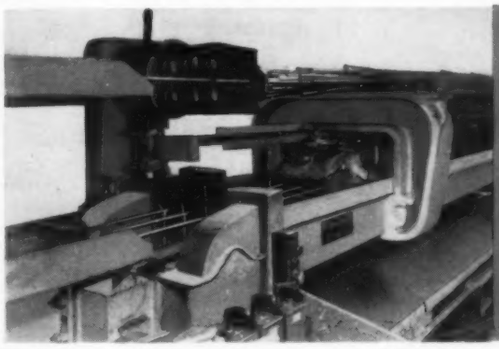
(at right) C-H Quick-Change Unit Panel for photo-electric limit switch used on automatic tube cut-off machine.

See this Control at Cleveland Iron & Steel Exposition, C-H Booths 46, 47, 58, and 59

NEW DRAWBENCH DEVELOPMENTS *by Aetna-Standard*



The three drawbench developments announced here by Aetna-Standard answer your demands for equipment which simplifies material handling and increases output of cold drawn bars or tubes.



TRIPLE DRAW

DUAL CHAIN DRAWBENCH—You have never seen a dual chain bench like this one. Material discharges through the bed, eliminating need for discharge arms. Draw can be started at zero speed and automatically accelerated to a pre-determined speed. High speed carriage-return by same motor used in pulling. The draw can be stopped at any point desired by the operator. Minimum amount of floor space required.

TRIPLE DRAW—With triple draw you can greatly increase output with the same man power. Old benches can be changed over to triple draw by equipping with new carriage, die stand and mandrel rod ends. Permits single, double, or triple draw of tubes over plugs. Since development of the triple draw by Aetna-Standard, many units have been installed.

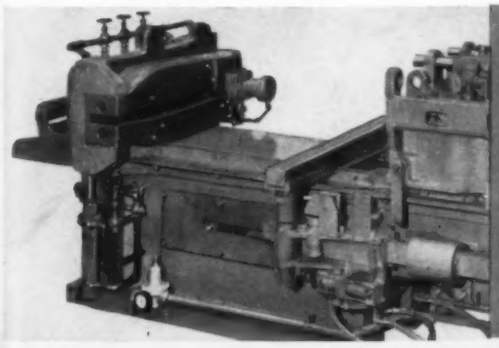
THE
AETNA-STANDARD ENGINEERING COMPANY

LOOK OVER THESE THREE CAREFULLY

275 WEST FEDERAL STREET
YOUNGSTOWN, OHIO

ASSOCIATED COMPANY
HEAD, WRIGHTSON & COMPANY, LIMITED, MIDDLEBOROUGH, ENGLAND

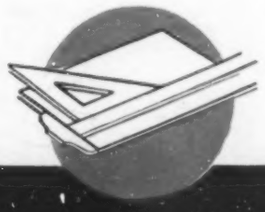
DUAL CHAIN DRAWBENCH
TRIPLE DRAW
SINGLE, DOUBLE, OR TRIPLE
PULL-THROUGH SHEAR
1, 2, OR 3 BARS



PULL-THROUGH SHEAR

PULL-THROUGH SHEAR—Take any size bar up to 1" in round, hexagon, or flat and the pull through shear will shear 'em 1, 2, or 3 at a time in any length you need. Speeds production when drawing bars from coils.

DESIGNERS AND BUILDERS
to the Steel, Non-Ferrous
and Chemical Industries



Aetna-Standard

3 REASONS WHY NATIONAL *makes* RELIABLE ROLLS

1 EXPERIENCE

Since 1909 the name *National* has been a highly respected factor in the metal working industry. The National organization, through knowledge accumulated over the years, has the right answer to any specific iron or alloy iron roll problem.

2 RESEARCH

In making rolls at National all metallurgical guesswork is eliminated. Constant analyses in modern laboratories keep check on every step of manufacture. Fundamental research for new and better materials is a never ending task. By careful attention to metallurgical detail, National produces roll castings having sound and long wearing physical properties.

3 EQUIPMENT

The most modern equipment is used in foundry and shop. The latest in furnaces, sand handling equipment, conveyors, cranes and machine tools facilitate production. Whether your requirements call for cast iron rolls in rough necked, rough turned or finished form, National is staffed and equipped to competently and speedily produce them.

NATIONAL ROLLS

National Rolls

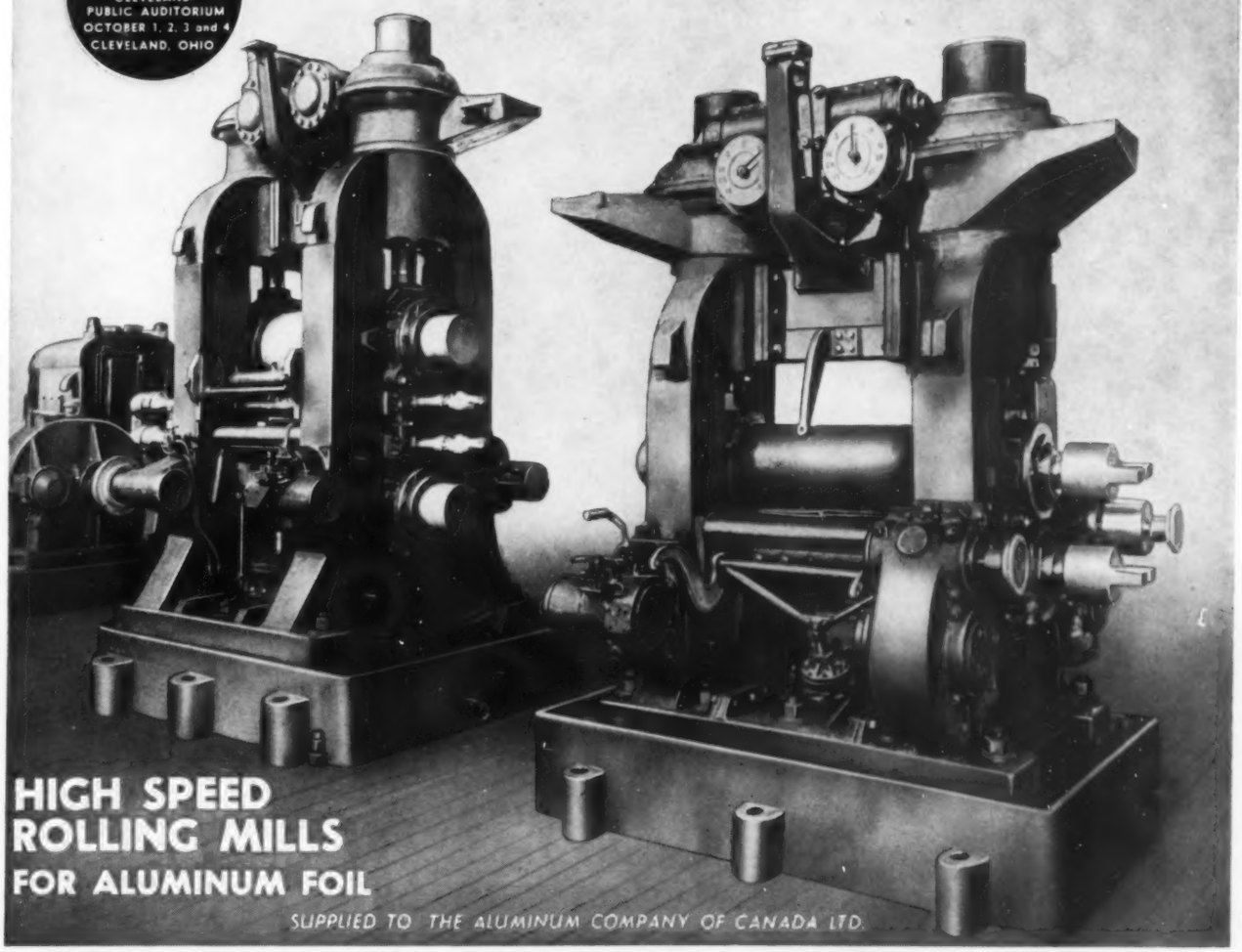
THE NATIONAL ROLL & FOUNDRY CO.

AVONMORE, PENNSYLVANIA

Manufacturing IRON AND ALLOY IRON ROLLS *Exclusively*

ROLLING MILLS AND ROLLING MILL EQUIPMENT FOR FERROUS AND NON-FERROUS METALS

BOOTH 352
IRON AND STEEL EXPOSITION
CLEVELAND PUBLIC AUDITORIUM
OCTOBER 1, 2, 3 and 4
CLEVELAND, OHIO



HIGH SPEED ROLLING MILLS FOR ALUMINUM FOIL

SUPPLIED TO THE ALUMINUM COMPANY OF CANADA LTD.

HYDROPRESS · INC.

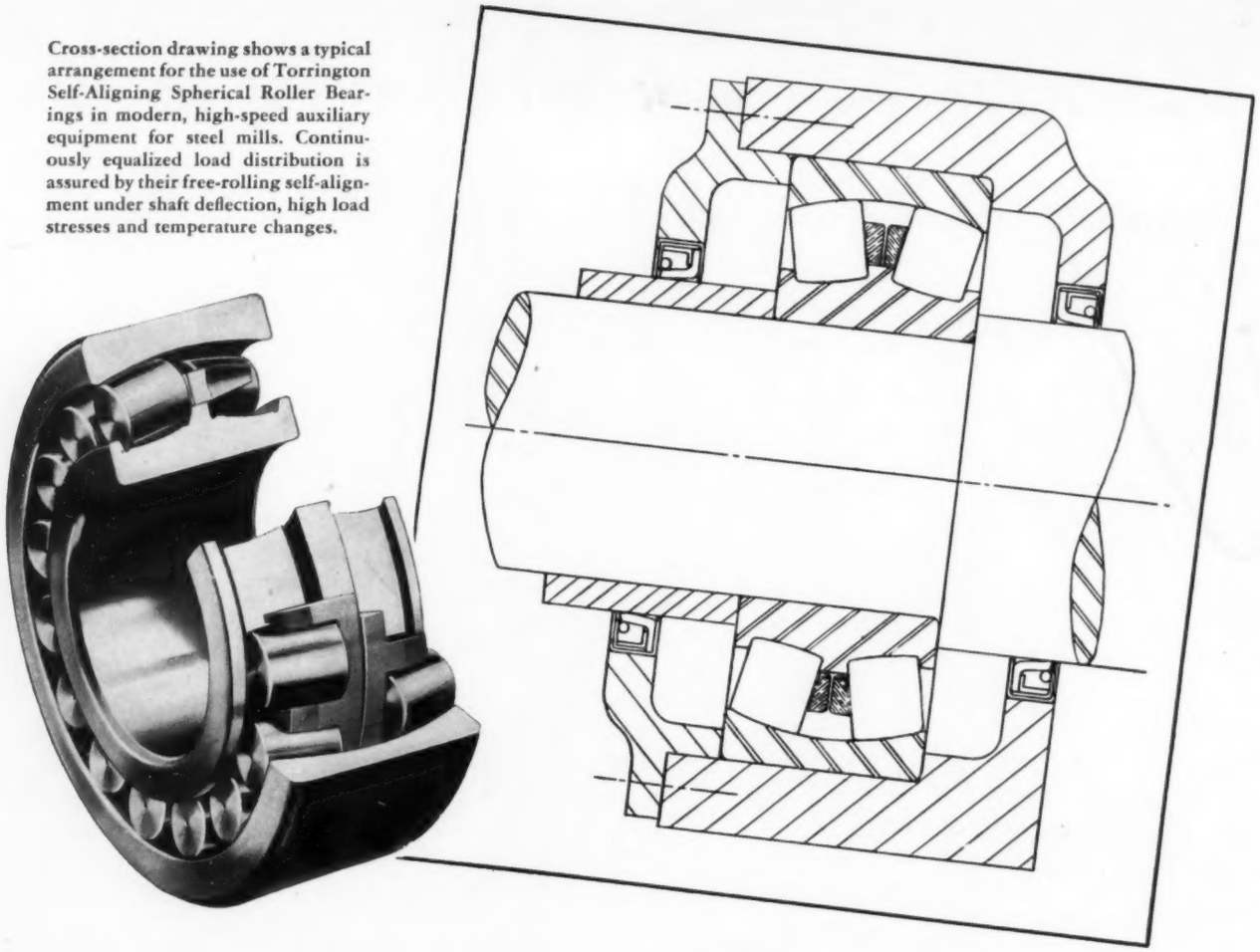
BOOTH 352
IRON AND STEEL EXPOSITION
CLEVELAND PUBLIC AUDITORIUM
OCTOBER 1, 2, 3 and 4
CLEVELAND, OHIO

ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ROLLING MILLS · PUMPS
ACCUMULATORS · DIE CASTING MACHINES

570 LEXINGTON AVENUE · NEW YORK 22 · N. Y.

Cross-section drawing shows a typical arrangement for the use of Torrington Self-Aligning Spherical Roller Bearings in modern, high-speed auxiliary equipment for steel mills. Continuously equalized load distribution is assured by their free-rolling self-alignment under shaft deflection, high load stresses and temperature changes.



FOR SUPERIOR PERFORMANCE

Throughout the steel industry, in charging cranes, edger rolls, trimmers, strip mills, table rolls and coilers, Torrington Self-Aligning Spherical Roller Bearings can handle heavy radial and thrust loads at high speeds. With equalized load distribution assured by their free-rolling self-alignment, they provide *sustained capacity.*

Consequently, the Spherical Roller Bearings' tremendous radial capacity... high two-directional thrust capacity...are little affected by shock loads, shaft deflection or frame misalignment. They are easy to install and service because of their unit construction . . . require a minimum of maintenance attention. This means *sustained operation* with fewer interruptions.

To help you adapt the Spherical Roller Bearing to machinery you design, manufacture or operate, Torrington's Bantam Bearings Division will be glad to offer practical engineering suggestions. For further information write for our Bulletin No. 200 or see your nearest Torrington Representative.

THE TORRINGTON COMPANY

BANTAM BEARINGS DIVISION • SOUTH BEND 21, IND.

TORRINGTON BEARINGS

SPHERICAL ROLLER • STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL

Another of the world's largest cranes...

built by Alliance

A new development of The Alliance Machine Company is this electro-hydraulic crane of 300-ton capacity. Alliance recently built 12 cranes of this type, ranging in capacities from 200, 250, and 300 tons, with spans up to 100 feet, for manipulating large forgings and armor plate under hydraulic presses. This is done by means of a 300-ton forge rotating block actuated by a motor on top of the trolley, the drive shaft extending through the hollow piston rod. This crane is of unique design inasmuch as the hydraulic power plant (water) — consisting of motor, pump, and tank — is located on the trolley, providing unlimited bridge and trolley travel of the crane. In addition, this type of crane offers four other outstanding features:

1. The trolley and rotating block can be racked closer to the center line of the press than with any other type of crane.
2. Because of adequate relief valves, it is impossible to overload the crane beyond the predetermined safe lifting capacity.
3. The pump is driven by a D. C. series motor, and the motor and pump work only when the crane is hoisting or lowering a load, thereby preventing unnecessary wear. This feature cuts maintenance to a minimum.
4. This type of crane can be arranged for remote operation from the floor, adjacent to the press, or from an operator's cage located on the crane.

Alliance also builds the conventional hydraulic type crane in which the power plant is located on the floor, the hydraulic medium being transmitted by means of jointed pipes (or walking pipes) to the hoisting cylinder on the trolley. This crane, usually arranged for remote operation, is controlled from a pulpit on the floor, adjacent to the press.

Consult Alliance on Cranes

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES
STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

THE ALLIANCE MACHINE COMPANY

ALLIANCE, OHIO • PITTSBURGH, PA. • 1622 OLIVER BUILDING

Alliance

Peace*

. . . yet much remains
To conquer still; peace hath her victories
No less renowned than war . . .

Milton

*In commemoration of our Victories, concluded by Presidential proclamation, September 2, 1945.

UNITED ENGINEERING AND FOUNDRY COMPANY
PITTSBURGH, PENNSYLVANIA

During the War, Producers of Ordnance and Essential Equipment for the Armed Forces . . .
In Peacetime the World's Largest Designers and Makers of Rolls and Rolling Mill Equipment.

Arc Furnace Troubles?—

FAULTY ELECTRODE ACTION HANDICAPS FURNACES—PREVENTS EFFICIENT OPERATION. THE REMEDY IS FAST-ACTING "REGULEX" CONTROL:

☛ "Regulex" rotating control accurately controls electrode position during all the changing conditions of the furnace charge, resulting in greater furnace output per kwh input.

☛ The "Regulex" control system is able to adjust itself instantly to any demand, no matter how small or how large—through sensitive variable-voltage control.

☛ The "Regulex" generator is a sturdy, standard commutator machine, which requires no tricky brush adjustments. Since no springs, levers or contactors are used in the control scheme, maintenance is slashed!

☛ As a unique A-C feature, "Regulex" control can be equipped with flywheels, which automatically raise the electrodes when a-c power fails. The auxiliary generator can make the entire control independent of a d-c shop source when desired.

☛ Your arc furnace manufacturer will be glad to tell you about "Regulex" control for new or existing furnaces. Or write directly to ALLIS-CHALMERS, MILWAUKEE 1, WIS.

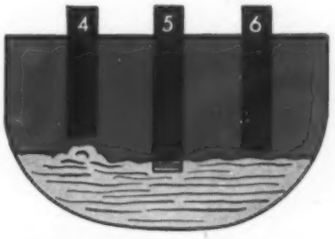
Six Conditions "Regulex" Corrects by Fast Action

MELTDOWN PERIOD

1. **REPEATED ARC INTERRUPTIONS,** due to sudden "settling" of metal. Sensitive "Regulex" generators reduce arc restrikes—thus meltdown time—by continuous, accurate adjustments.

2. **INSTABILITY OF ARC,** due to inaccuracy of control for raising electrode when short circuit occurs. "Regulex" variable voltage control raises electrodes *just the right amount*—keeps arc values constant.

3. **BREAKAGE OF ELECTRODES,** caused by caving in of metal charge against electrodes. Fast-acting "Regulex" control pulls electrodes safely out of a cave-in. "Regulex" generators also conserve electrodes by reducing number of arc restrikes—thus limiting mechanical shock to electrodes.



REFINING PERIOD

4. **WASTE OF POWER,** as a result of current surges when metal boils up against electrodes. "Regulex" variable voltage control raises electrodes with acceleration directly proportional to amount that arc current and voltage deviate from normal values . . . lower power input results.

5. **FREEZING OF ELECTRODES** in molten bath, due to electrode "drift" when a-c power fails. Only the "Regulex" generator set is provided with a flywheel for automatically raising electrodes upon a power failure . . . preventing electrode breakage, and carbon contamination of the molten metal charge.

6. **BURNING OF ELECTRODES** during refining period, because of using too short an arc. Accurate "Regulex" control permits use of longer arc—conserves your arc furnace electrodes.

Allis-Chalmers

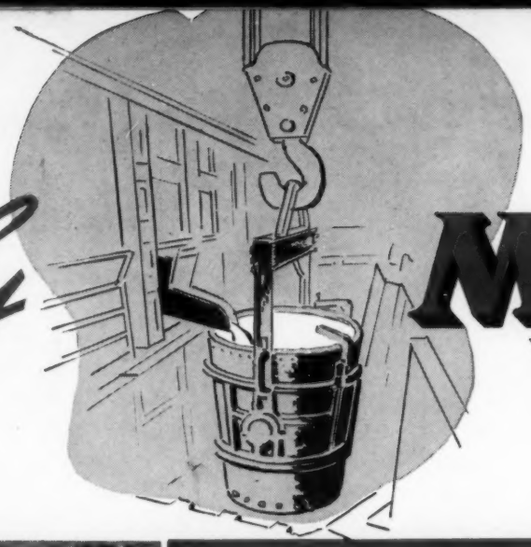
"REGULEX"

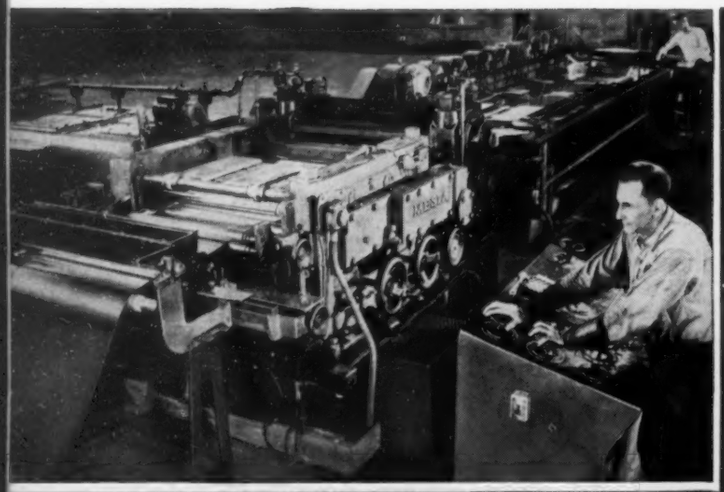
Arc Furnace Control

A 1939

HEAR THE BOSTON SYMPHONY: *Every Saturday Evening, American Broadcasting Co.*

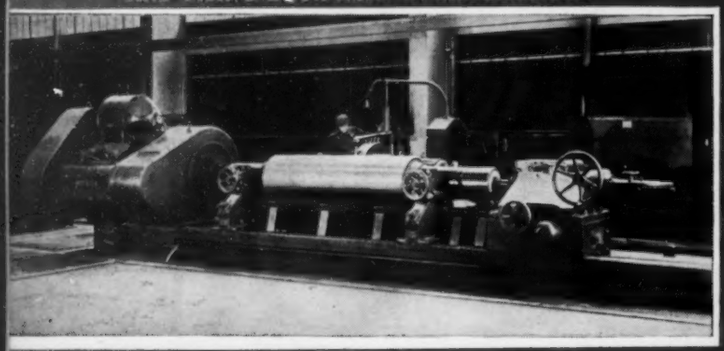
Built by MESTA



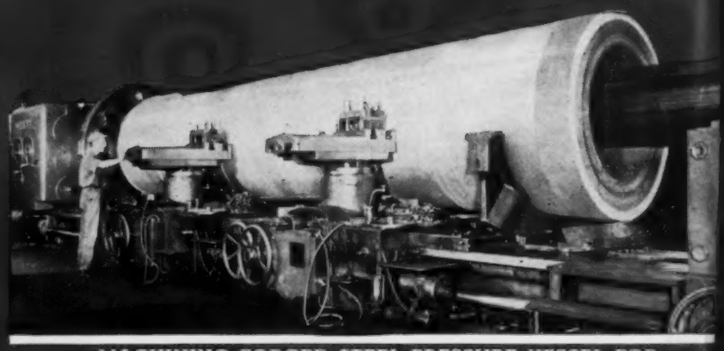


MESTA 42" TIN SHEARING LINE, SHOWING MESTA PATENTED FLYING SHEAR AND LEVELLER WITH CLASSIFYING AND PILING EQUIPMENT IN BACKGROUND

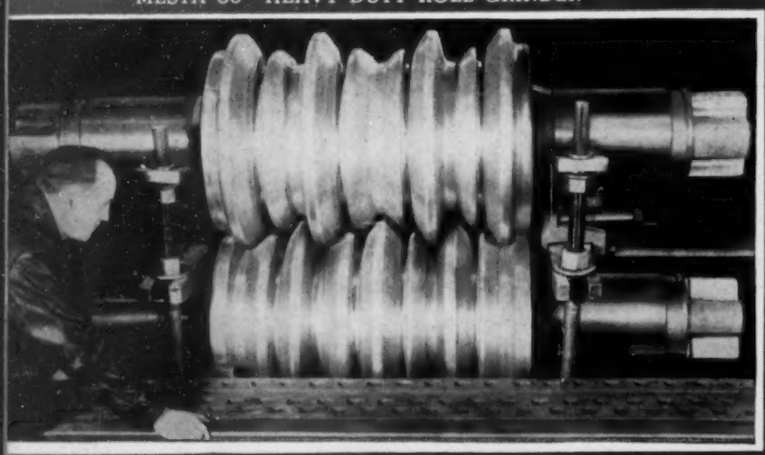
Unequalled plant facilities, equipped with the most modern precision machinery, and manned by skilled workmen with long service records, an engineering staff whose technical ability has been accumulated over many years—these resources are responsible for Mesta's leadership in the design and production of the largest heavy duty steel mill equipment, the size of which is limited only by the carriers' transportation facilities.



MESTA 60" HEAVY DUTY ROLL GRINDER

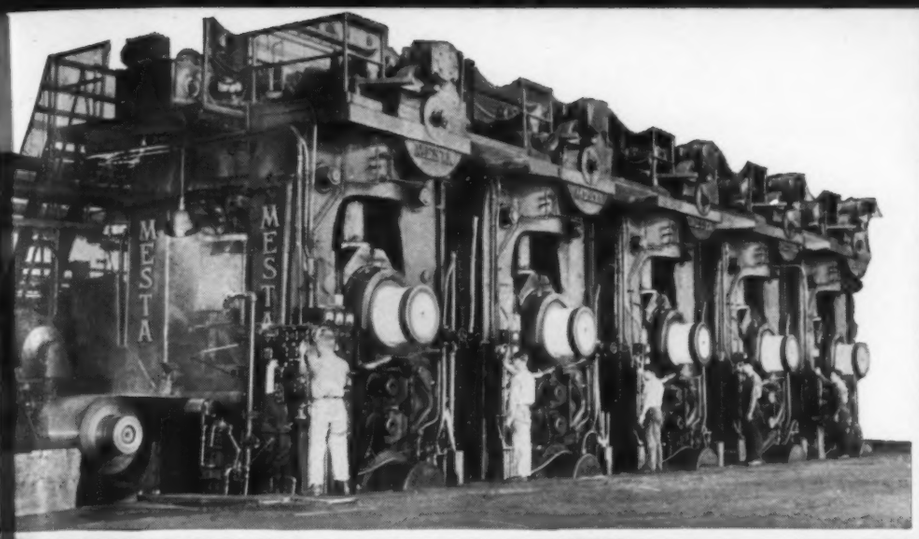


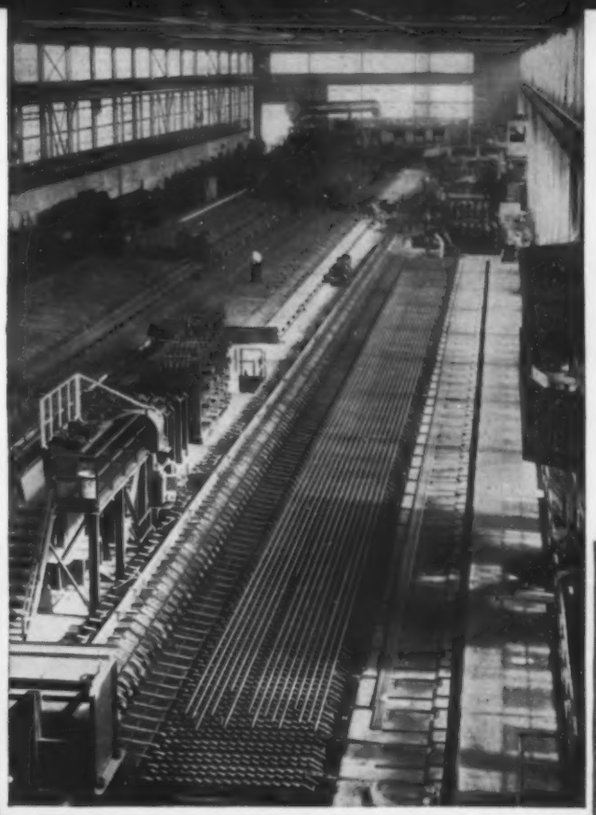
MACHINING FORGED STEEL PRESSURE VESSEL FOR MESTA 18,000 TON HYDRAULIC PRESS



MESTA MERCHANT MILL ROLLS FOR ROLLING I-BEAMS

MESTA 66" CONTINUOUS PICKLING LINE WITH TRIMMERS AND UPCOILERS



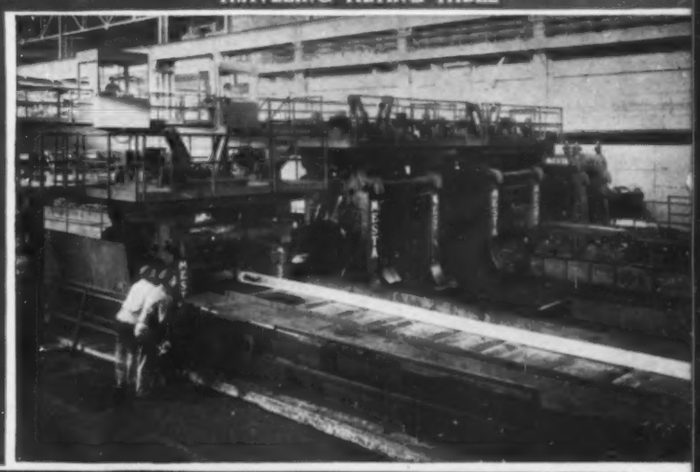


MESTA 42" HIGH SPEED FOUR-HIGH TANDEM COLD MILL FOR ROLLING TIN PLATE GAUGES

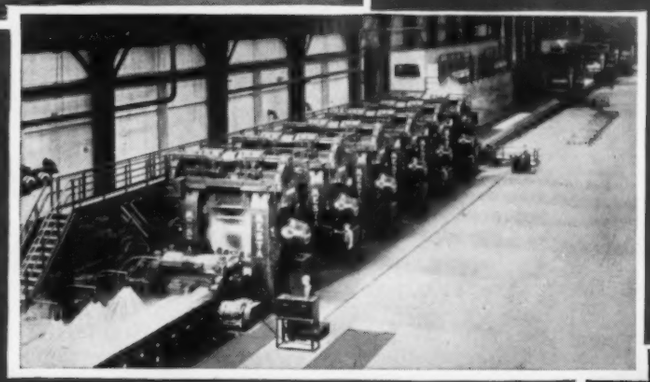
MESTA 18"—14"—10" MERCHANT MILL WITH PACK ANNEALING COOLING BED

MESTA 29" STRUCTURAL MILL WITH TRAVELING TILTING TABLE

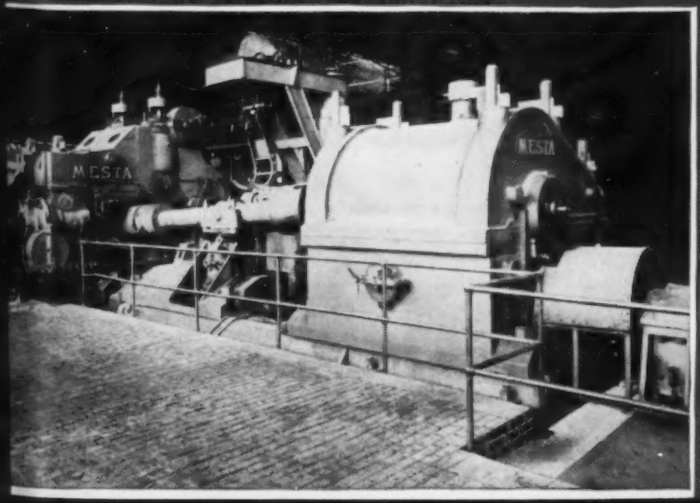
DISCHARGE END OF MESTA 42" CONTINUOUS ELECTROLYTIC TIN PLATING LINE



MESTA 80" FOUR HIGH CONTINUOUS STRIP MILL



MESTA PIERCING MILL AND DRIVE



42" TWIN FOUR-HIGH SKIN PASS MILL FOR TIN PLATE

MESTA MACHINE COMPANY · PITTSBURGH, PA.

ENGINEERED HEAT for production Economy

● Salem specializes in planning, designing, building, and installing of heating equipment and the production facilities leading up to and beyond the actual heating operation. Our experience embraces all sizes and types of plants such as forge shops, pipe plants, rolling mills, and brass strip mills.

Salem furnaces and allied equipment literally fit into production lines. And Salem's practical suggestions usually stimulate economy in the allover production job.

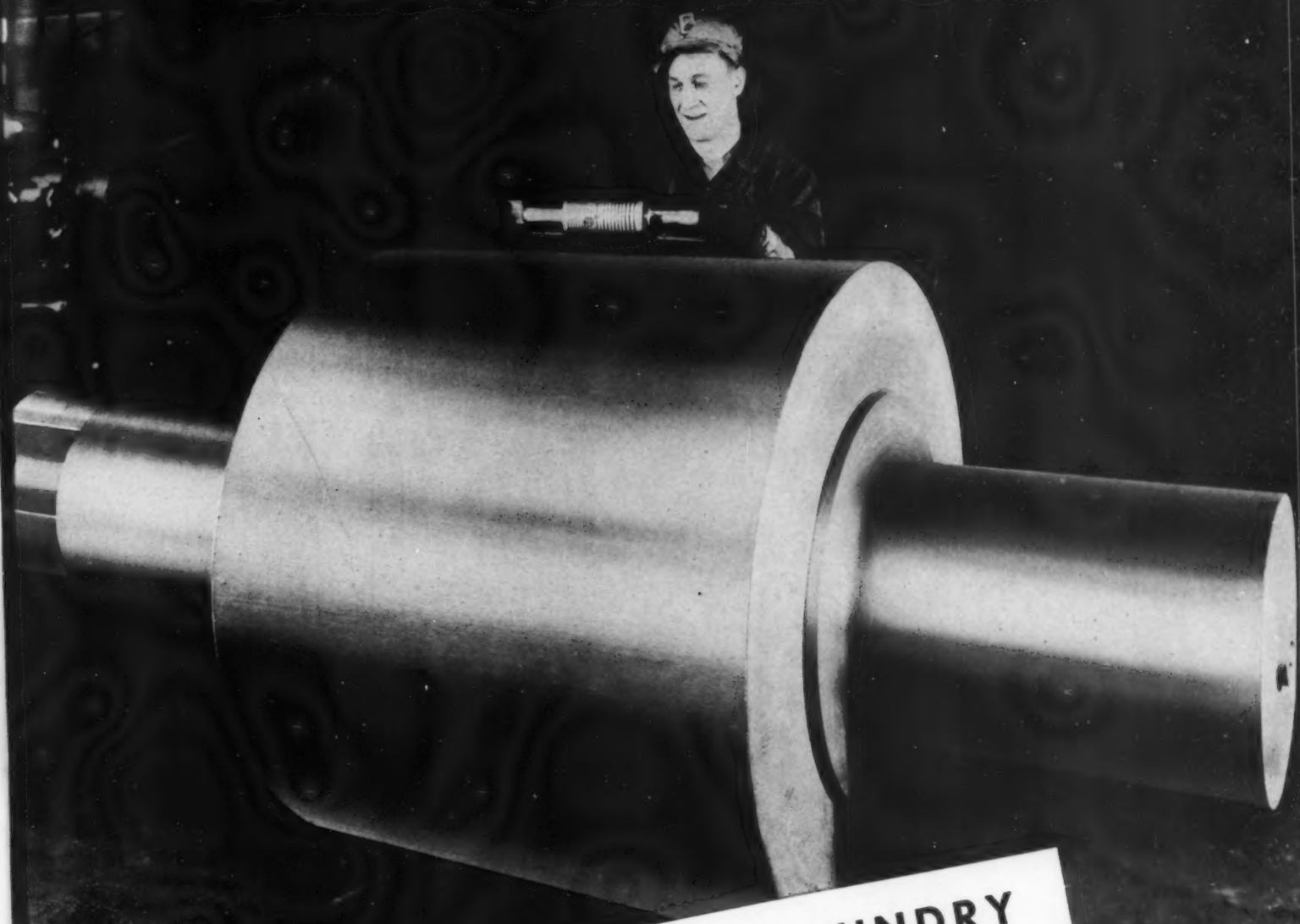
As evidence of new Salem developments which were based upon production economy, we point to the world's largest rotary furnace, all of America's butt weld pipe mills, all circular soaking pits, small arms ammunition plants, as well as Salem continuous annealing and heat treating furnaces, also, Salem batch type ingot heating furnaces operating throughout America and abroad.

Avail yourself of Salem's engineering experience in designing your new production facilities. Investigate the production and economic advantages of Engineered Heat.

SALEM

SALEM ENGINEERING CO.
SALEM, OHIO
TORONTO, ONTARIO, CANADA
LONDON, ENGLAND

FROM A "Mill-Minded" ORGANIZATION



LEWIS FOUNDRY and MACHINE

DIVISION OF BLAW-KNOX CO., PITTSBURGH, PA.

ARMY NAVY

DESIGNERS AND BUILDERS OF ROLLS AND ROLLING MILL EQUIPMENT

A "Mill-Minded" Organization which produces
Rolls and Rolling Mill Machinery for men
whose principal objective is the production
of more and better steel and non-ferrous metals.

Wapakoneta SHEAR BLADES and SLITTERS ...

ENGINEERED FOR THE JOB

MORE THAN 50 YEARS of Service

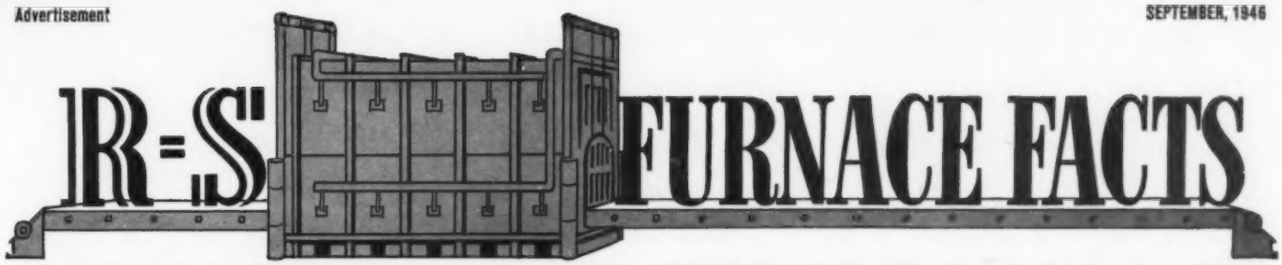
THEY HOLD THE EDGE

because they are tempered and ground for your particular needs

Wapakoneta Shear Blades are made and heat treated, ***not*** to meet some universal standard of our own, but to best fill each customer's requirements... That is why Wapakoneta Shear Blades stand up longer on the job and cut more tonnage.

The Wapakoneta Machine Company

INCORPORATED 1891 — Wapakoneta, Ohio U.S.A.



ISSUED MONTHLY BY R-S PRODUCTS CORPORATION, PHILADELPHIA 44, PA., FOR THOSE CONCERNED WITH QUALITY HEATING OF METALS

Even in Big Furnaces it's the Little Things that Count

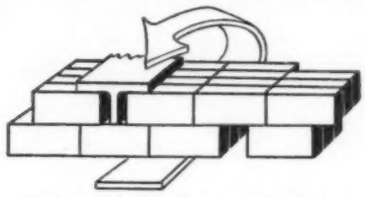
Keep your eye peeled to the "little" things when you compare furnace designs and prices. For the little things make the big difference in operating convenience, furnace life, product quality and overall running cost.

Here are a few of the little details built into R-S furnaces for over 38 years—details which "go beyond the line of duty" in nipping trouble before it starts.

Look first at the door hoist mechanism. In every R-S design you'll find a spur gear transmission betwixt hand-chain sheave and door-lift sheave. It gives a mechanical advantage which saves muscle, and brakes unwanted door movement.

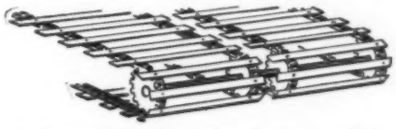
Look at the arch. If it's over 12 feet across, beware of the cheaper sprung design. Modern insulating refractories, however remarkable in thermal characteristics, fall short as regards yield in compression. Every R-S arch over 12 feet is flat—with individually hung bricks.

Look next at the hearth—and its expansion joints. In the ordinary furnace, scale can fall into that joint, eventually jam it, and shorten hearth life. But not in an R-S. Each joint is made oversize by the thickness of the vertical web on a



molded-and-fired refractory T which caps the gap.

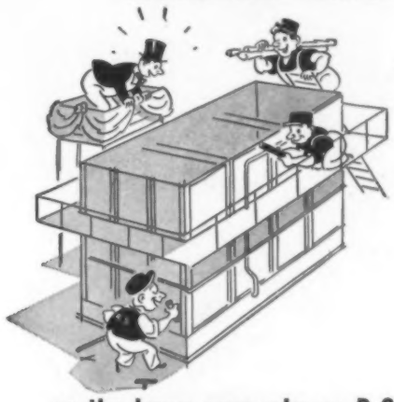
Look finally at wide chain-and-slat conveyors. Under temperature and continued service no two chains will expand just alike. A single 8-foot slat bolted across 4 or 5 chains will strain or cause



stutter as the chains give. R-S never bolts a slat at more than two places—even if it means two 4's in place of every 8. Thus slat ends can give, and chains stay free and easy.

And so it goes . . . for R-S knows that even in big furnaces it's the little things that count.

WE LIKE SIDEWALK SUPERINTENDENTS!



. . . so the buyer sees why an R-S furnace is worth more than it costs

R-S builds only "on location". It doesn't fabricate at home and just assemble in public. It wants the men who matter to be able to see every joint before it's hidden, to count every buckstay as it's welded in, to kibitz on fussy special burner settings, and to watch the work-handling mechanisms adjusted.

That way they *know* why they get faster production, better metallurgical results, smoother mechanical handling, and less maintenance over extra long furnace life—they're *sure* they acted wisely when they advised taking the R-S bid.

Report on Giant Magnesium and Aluminum Forging Job Available

At Grafton, Mass., (Wyman-Gordon) three noteworthy R-S apron-conveyor furnaces (each rated at 4400 lbs. of billets per hour) serve an 18,000-ton press. An R-S roller-rail furnace (2,000 lbs. per hr.) heat treats the final forgings. All are forced convection furnaces, with independent zone control. The temperature uniformity (within 2°F) is exceptional for such size. The installation has been reported in detail with photographs. Write S. M. Stoler, Sales Mgr., R-S Products, Phila. 44, for your free copy.

Better Heat Distribution and Fuel Economy With Oil Firing

R-S engineers are much interested in Fred Bloom's new "unit atomizer" which employs high pressure steam (80 to 125 psi) to gasify up to 125 gph of heavy fuel oil, and supplies as many as 10 separate furnace burners from one control point.

The new device permits designing for more and smaller burners, with consequent gains in the power to manipulate heat distribution throughout the furnace chamber. It further permits using heavy oil on jobs for which gas or lighter oils would ordinarily be specified.

Applications which immediately suggest themselves include strand annealing, cycle hardening, and all continuous mesh-belt or conveyor processing.

Write Fred Bloom in Pittsburgh for a copy of his Bulletin No. 1077.

Here We Are! Now, why?

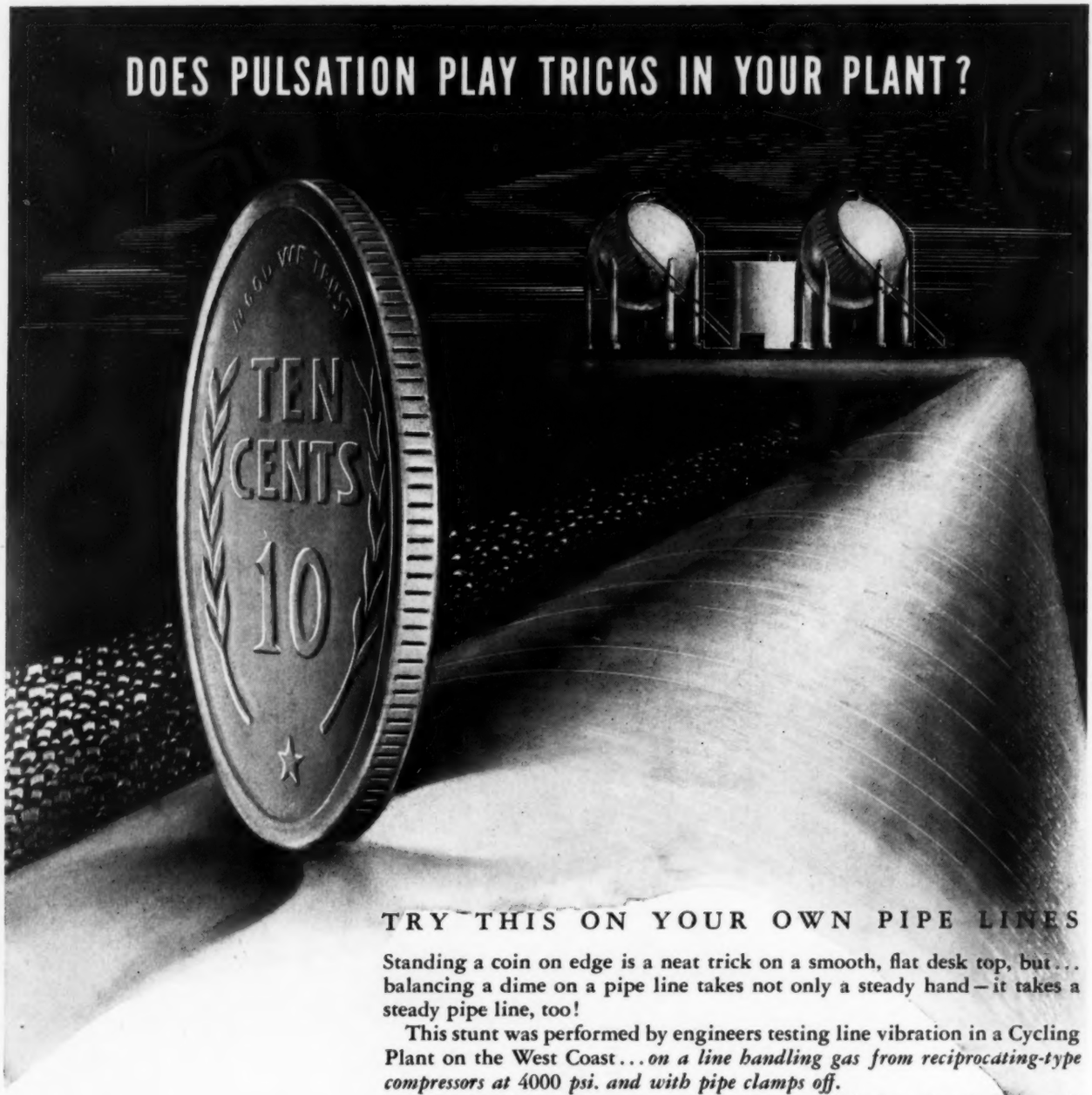
Here we are with our first edition of FURNACE FACTS. You'll see us in this publication monthly from here out.

And here's why!

We believe that there has been too much furnace buying on the basis of hope and hokum—too little on the basis of information and fact. Our aim is to get down to cases—on what makes a furnace a good furnace. Our means of attaining that end will be our advertising space—loaded with what we believe will help you most—news and FACTS.

JMLco J-2

DOES PULSATION PLAY TRICKS IN YOUR PLANT?



TRY THIS ON YOUR OWN PIPE LINES

Standing a coin on edge is a neat trick on a smooth, flat desk top, but... balancing a dime on a pipe line takes not only a steady hand—it takes a steady pipe line, too!

This stunt was performed by engineers testing line vibration in a Cycling Plant on the West Coast... *on a line handling gas from reciprocating-type compressors at* 4000 *psi. and with pipe clamps off.*

FLUOR Pulsation Dampeners, installed as original equipment on each high pressure discharge lateral in this plant, convert pulsative flow—inherent when reciprocating compressors are used—to a smooth, steady stream. By installing FLUOR Pulsation Dampeners *when the plant was built,* vibration caused by pulsative flow was stopped before it could get started. If you are planning to build a new plant or additions to your present facilities, it will pay you to investigate the FLUOR Pulsation Dampener now.

FLUOR Pulsation Dampeners eliminate the expense of accessory equipment to absorb vibration, such as clamps, anchors and expansion chambers; they save the extra cost of over-sized pipe and extra bends and effect substantial reductions in horsepower cost. This means a saving in original plant cost which more than pays for the FLUOR Pulsation Dampeners installed, plus lower operating and maintenance costs for the life of the plant.

WRITE FOR
FLUOR GENERAL CATALOG
NO. 46

BE SURE WITH FLUOR SINCE 1890

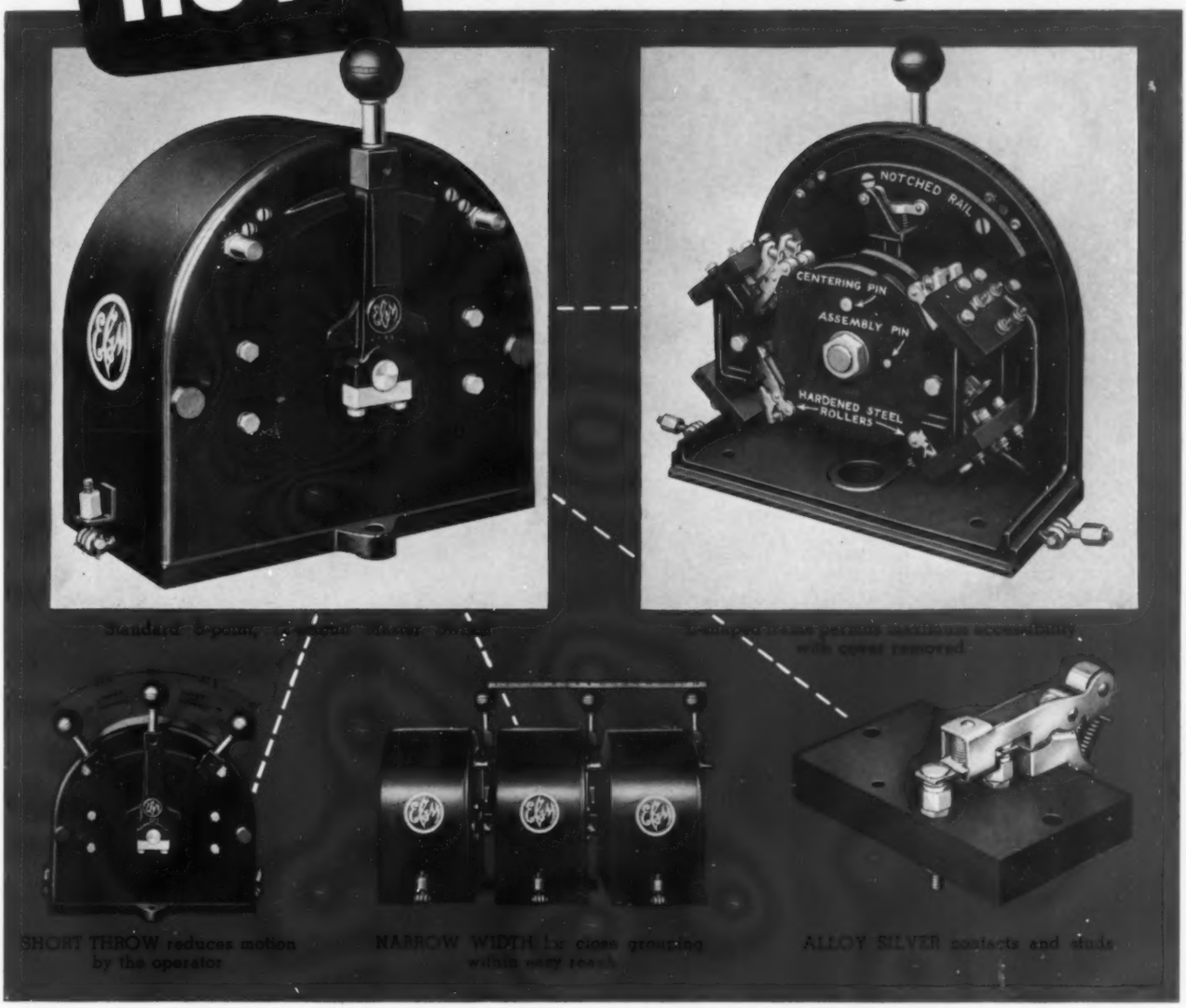
FLUOR PULSATION DAMPENER

THE FLUOR CORPORATION LTD., 2500 South Atlantic Boulevard, Los Angeles 22
NEW YORK • PITTSBURGH • KANSAS CITY • HOUSTON • TULSA • BOSTON

ENGINEERS • MANUFACTURERS • CONSTRUCTORS

new EC&M {CAM TYPE} Master Switch

for use with MILL & CRANE magnetic controllers


NOTCHED RAIL
CENTERING PIN
ASSEMBLY PIN
HARDENED STEEL ROLLERS
SHORT THROW reduces motion by the operator
NARROW WIDTH by close grouping within easy reach
ALLOY SILVER contacts and studs

These new EC&M Type CM Master Switches incorporate in their design many advantages of outstanding importance. The use of 7-inch diameter cams results in a saving in motion by the operator (*short throw*), reduces mounting space required when several switches are installed in a mill pulpit or crane cab (*narrow width*), making it easy for an operator, without changing his position, to reach and operate them conveniently.

Cams are mounted on the shaft and keyed in position by a centering-pin, screwed into the keyed roller-arm bracket. The assembly-pin identifies the arrangement of cams for right or left hand operation. The notched centering-device rail contributes to smooth and easy operation, and is so located that increased roller-spring pressure is automatically obtained as the lever-arm is advanced to the full-on position. This offsets the weight of the operating-lever without sacrificing ability to inch easily between the off and first points.

New literature 1190, just issued, gives complete data on weights, sizes, dimensions, etc. Copy will be mailed promptly upon receipt of your request.

THE ELECTRIC CONTROLLER & MANUFACTURING CO.

2698 EAST 79th STREET • CLEVELAND 4, OHIO

Now! LIFT, MOVE, STACK Materials Electrically with NEW TRANSTACKER

PRICED AT ONLY **$1800**
(Some Models Slightly Higher)

PLATFORM TYPE TRANSTACKER

Capacity 4000 pounds

For stacking unit loads on skid platforms.

Above price applies in U. S. only.

Low price brings modern material handling methods within reach of all!

NOW for the first time every business—every industry can use modern, money-saving material handling methods at new low cost.

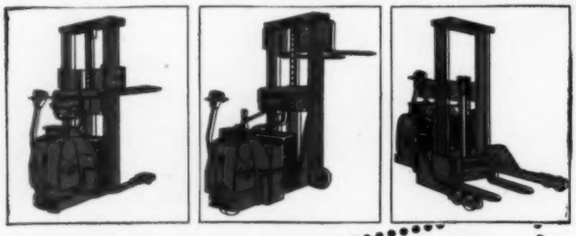
Because in the new Transtacker, Automatic's engineers have developed a high-lift stacker that sells for as low as $1800. And while it will move, lift and stack up to 4000 pounds, it weighs only 1900 pounds. This means you can safely use Transtacker, even if your floor and elevator capacities are limited.

With all the advantages of the famed Transporter that moves any kind of material with amazing "touch-of-your-thumb" ease, Transtacker now gives you an electric hydraulic lift that stacks your product at new heights to increase storage capacity. With finger-tip control it lifts up to 4000 pound loads in a matter of seconds . . . smooth, controlled lowering speed for utmost safety. Mail coupon for facts.

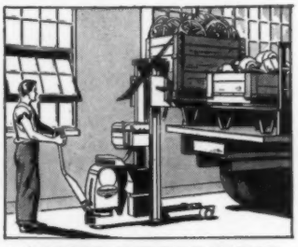
OPEN FACE PALLET TYPE TRANSTACKER—Capacity 3000 pounds—With suitable forks for stacking open face pallet loads.

SUSPENDED LOAD TYPE PALLET TRANSTACKER—Capacity 2500 pounds—With suitable forks for stacking double or open face pallets.

STRADDLE TYPE PALLET TRANSTACKER—Capacity 4000 pounds—With suitable forks for stacking double face or open face pallet loads.



FINGER TIP CONTROLS LOAD
Cartons, crated goods, hard-to-handle material—one man or girl hauls, lifts and stacks to full storage heights.



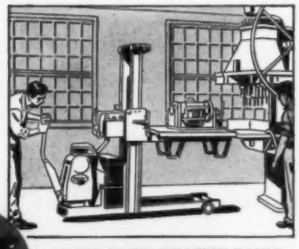
ENORMOUS SAVINGS IN SHIPPING
Pick up merchandise from ground level and deposit it on truck or trailer. A three-man operation becomes a one-man operation.

PRE-TESTED IN INDUSTRY

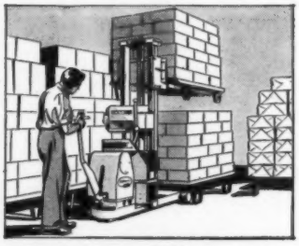
1. Cuts loading and unloading time in half.
2. One man does the work of three with less effort—Transtacker cuts handling costs up to 60%.
3. Light in weight for limited floor and elevator load capacity.
4. Hauls any kind of product with "touch-of-thumb" ease.
5. Gives you extra storage space without added cost.
6. Lifts and stacks product from ground level to trucks and trailers.

LOOK TO THE LEADER FOR ALL THAT'S NEW!

Transtacker
A PRODUCT OF AUTOMATIC
Lightens LIFE'S LOADS



LIFTS HEAVY MACHINE PARTS
When heavy machine parts must be lifted to working height, let Transtacker safely lift it and place it.



ENDS BACK-BREAKING HANDLING
This can be *your* trucker—easily, efficiently stacking your material with Transtacker. Extra storage space is yours free.

AUTOMATIC TRANSPORTATION COMPANY
DIV. OF THE YALE & TOWNE MFG. CO.
47 West 87th St., Dept. P, Chicago 20, Illinois

Please mail me without cost or obligation, complete facts about the NEW TRANSTACKER.

( ) Have an A.T.C. Specialist call and survey my material handling costs.

Company Name.....

By..... *Position*.....

Street Address.....

City..... *State*.....

Better your product

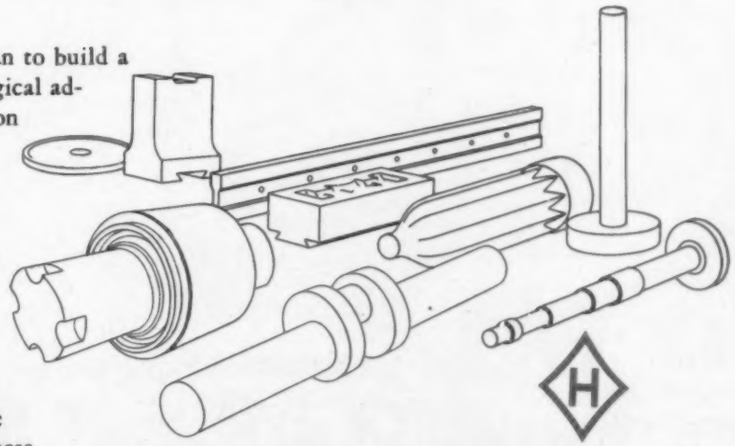
---

and your production with

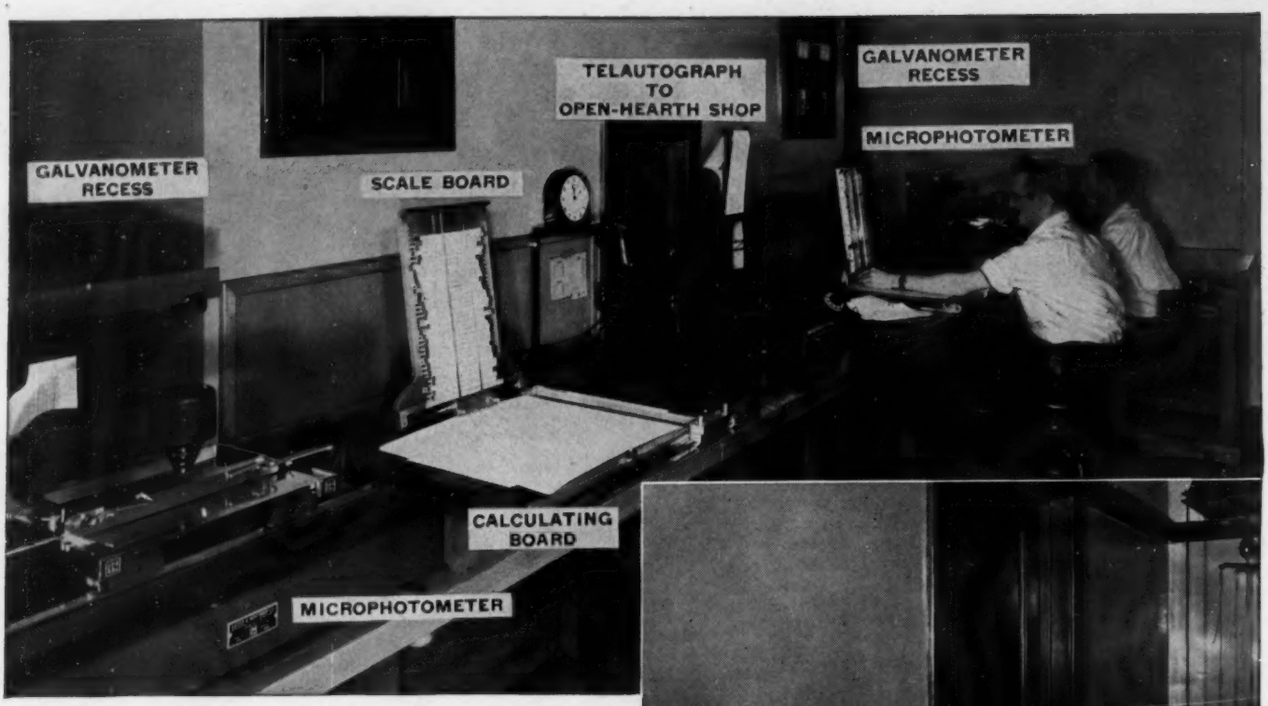
Heppenstall Forgings!

Three generations ago Heppenstall Forgings began to build a reputation. Constant technological and metallurgical advancements—and an undeviating, rigid supervision of quality—have brought them their present day regard by exacting users . . . "For extra safety and maximum service life, there are no finer forgings than Heppenstall."

Consider Heppenstall Forgings for the vital working parts of your products, and for your machines which produce them. In your product, they will assure user satisfaction and repeat sales. In your production equipment, they will eliminate costly maintenance delays, reduce your manufacturing costs . . . Why not investigate these very real ways to better your product and its production?



HEPPENSTALL COMPANY



Above, Room containing Vincent-Sawyer Microphotometers in a steel mill's spectrochemical control laboratory. Here five men handle the control and heat analyses for the open-hearths and electric furnaces. The other three men on the shift stepped out of this picture so we could show the microphotometer at the left.

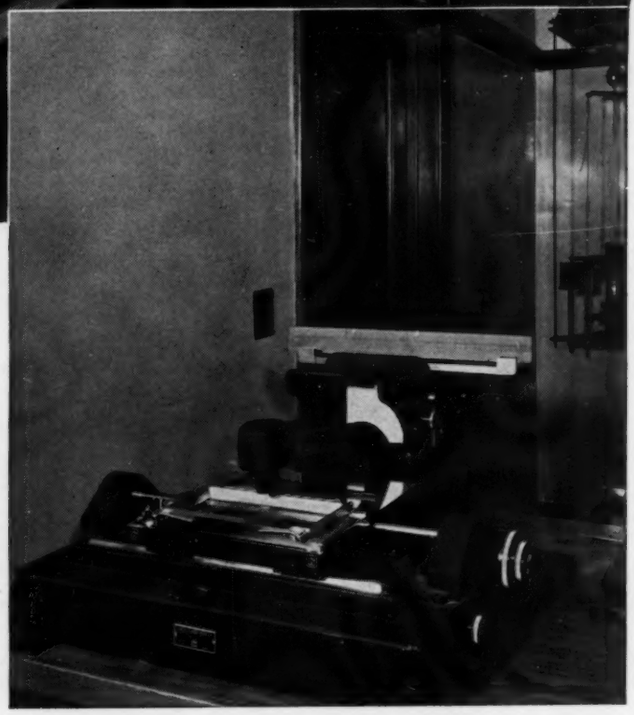
Steel Analyzed in Minutes With New Microphotometer

An average of 15 minutes from the time a sample is received until the composition has been reported — that is the speed of routine analyses in an Eastern steel mill.

This extra-fast analysis, accomplished with the L&N Vincent-Sawyer Microphotometer, enables open-hearth and electric furnace helpers to bring the analysis of each melt closely to specifications; cuts the total time per heat.

Samples from electric furnaces and open-hearths are sped by pneumatic tube to the laboratory, where exposures (spark or arc as required) are taken, developed and sent to the microphotometer room. An operator next measures densities of preselected spectrum lines with the microphotometer. Another operator translates density ratios into percentages of elements, and the foreman then examines the analysis and sends it by Telautograph to the open-hearth shop.

Designed for rapid, routine analyses rather than for research, the L&N Vincent-Sawyer Microphotometer has the following advantages in addition to speed:



Close-up view of Microphotometer and galvanometer assembly.

1. Exceptional accuracy and stability. Positioning of the spectrum plate is rapid and highly precise. Photoelectric scanning is sharp and accurate. Indicator is an L&N Type HS Galvanometer whose high sensitivity makes an amplifier unnecessary; readings are free from pick-up.

2. Easy and simple to use. Operation requires only a few simple, natural motions and a minimum of eye movement — important factors in reducing fatigue and error.

The instrument is described in detail in an 8-page folder which we'll be glad to send on request. Ask for Reprint F-90(1).

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA. 44, PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl. Ad E-90(4)

Modernize and Reduce Rolling Costs with...

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Vertical Mills

One good turn usually deserves another but not always on rolling mills. With the Continental Vertical Mills, twisting of billets in continuous mills is eliminated. Look always to CONTINENTAL for cost saving advancements in rolling mill equipment that help keep you in the competitive picture.

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FOUNDRY & MACHINE CO.

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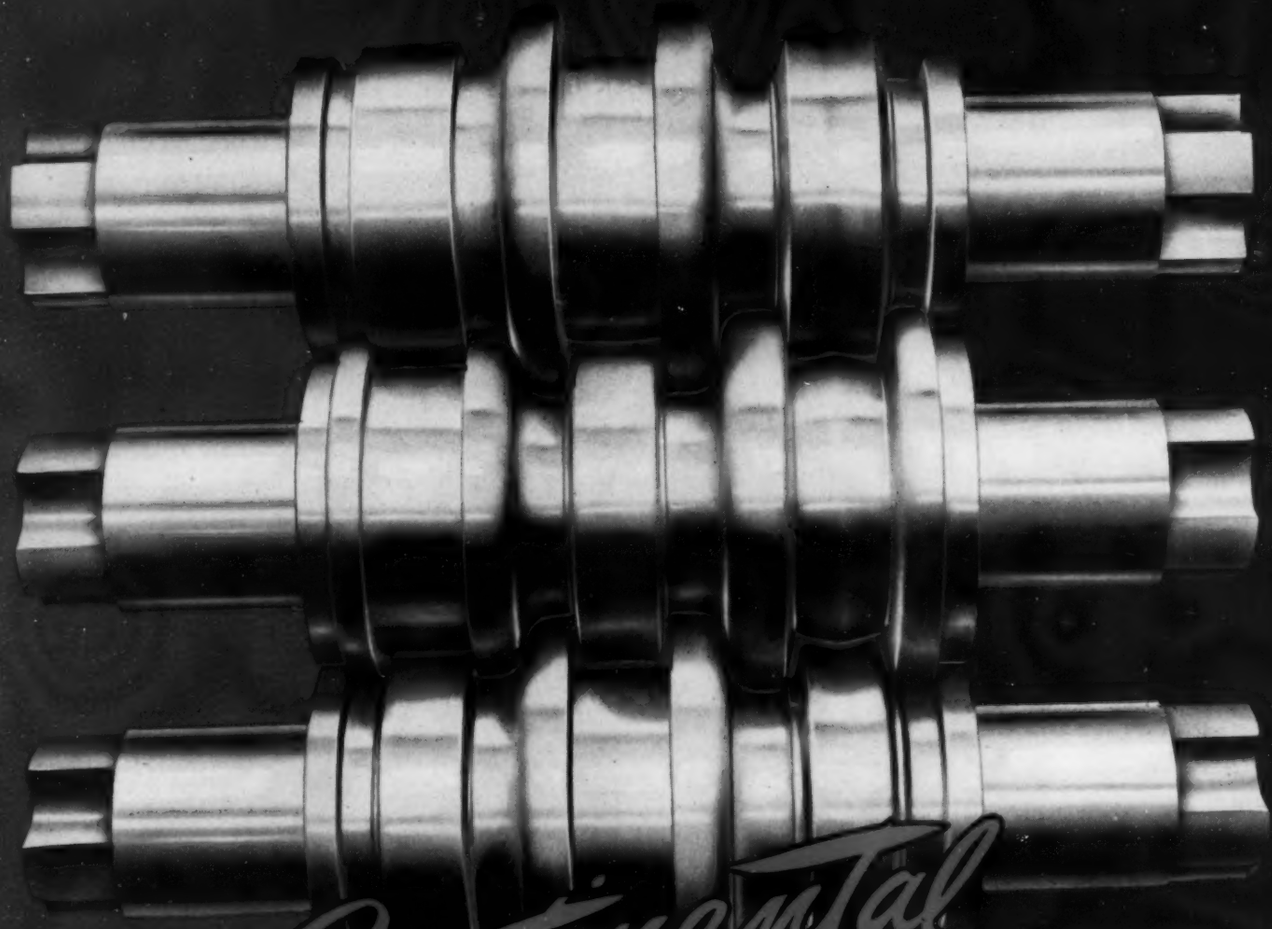
The *RIGHT ROLLS*

for Every Ferrous or Non-Ferrous Rolling Mill Application



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IRON ROLLS · STEEL ROLLS

Engineered

for maximum production and longer trouble-free [illegible]

Master craftsmanship, years of intimate experience with rolling mill design and operation plus practical engineering which utilizes the full facilities of [illegible] plants . . . your assurance that CONTINENTAL has the tried and tested answers to roll problems on every type of mill.

Continental

FOUNDRY & MACHINE C

PITTSBURGH · CHICAGO

Plants at: E. CHICAGO, IND. · WHEELING, W. VA. · PITTSBURGH

HUNT Quick-As-Wink VALVES INSURE SAFE OPERATION FOR NEW NATIONAL ACME CHUCKING MACHINE

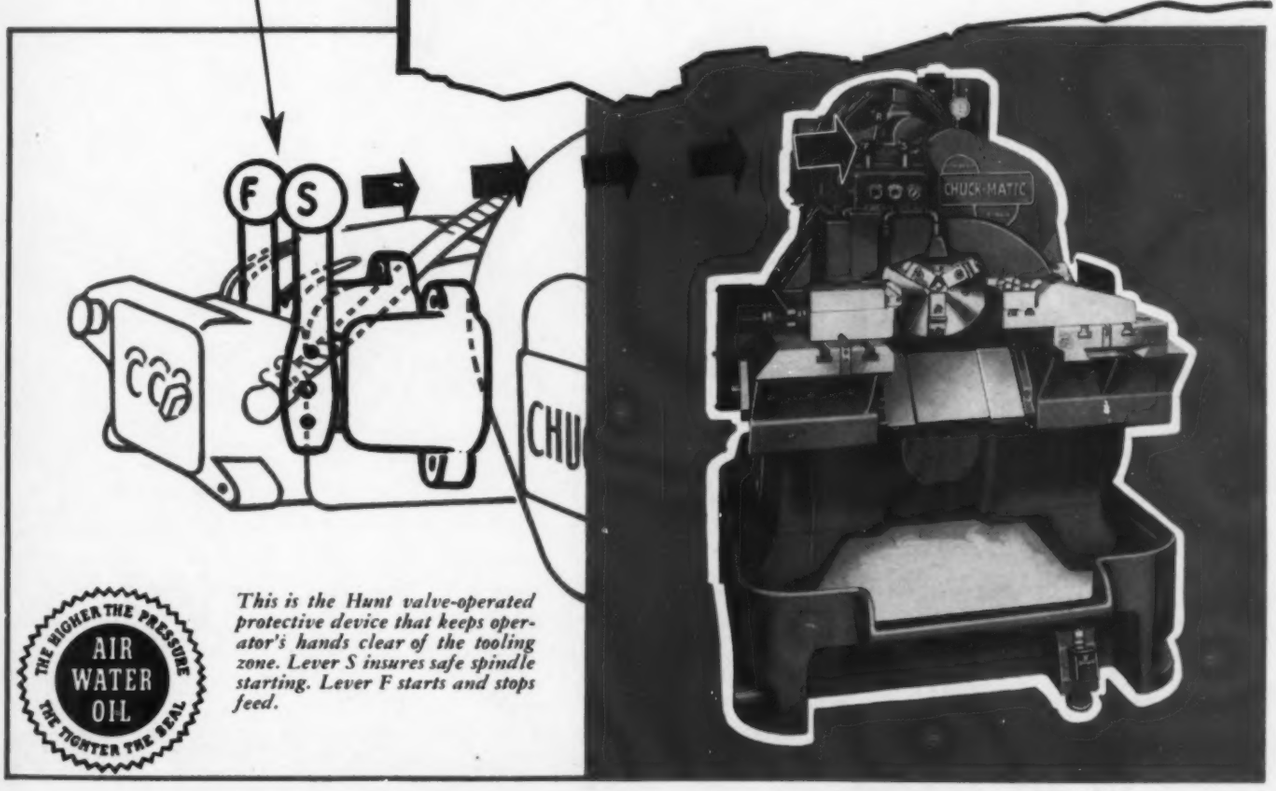
Quick-As-Wink
HUNT CONTROL VALVES

A new single spindle automatic chucking machine has been developed for heavy-duty, high production machining operations on castings, forgings, and tubing parts. One of the most important features of this Acme-Gridley machine is a safety device — operated by Hunt valves — which eliminates any possible injury to the operator.

To start the spindle, the safety locking spring plunger (at left of push buttons) is pushed in with the left hand while the spindle starting lever (S) is pulled with the right hand. The safety plunger must also be pushed to operate lever F, starting the feed. This protective device forces the operator to use both hands in starting . . . keeps both hands clear of the machining area when the work cycle begins. Stopping action, too, is automatic, and levers F and S stop feed and spindle quickly whenever necessary. Levers F and S control Hunt Quick-As-Wink 4-way air valves, enclosed in aluminum housings. These valves are the sliding sleeve type, designed for normal service air of 80 to 100 pounds, and temperatures below 150°F. For higher pressures and temperatures, Hunt supplies modifications of these standard valves. All of these are available in regular and automatic return actions, 2, 3 and 4 way.

The new Acme-Gridley Chuck-Matic is but one example of the use of Hunt Quick-As-Wink valves to insure positive precision control of air, water, or oil. Perhaps you, too, have a situation which calls for a valve of the hand operated, foot operated, solenoid, diaphragm, or of special action. Write today for further information, and for your free copy of the new Hunt Bulletin No. 107.

Visit our booth (40 and 41) at the Iron and Steel Exposition, October 1, 2, 3, 4.



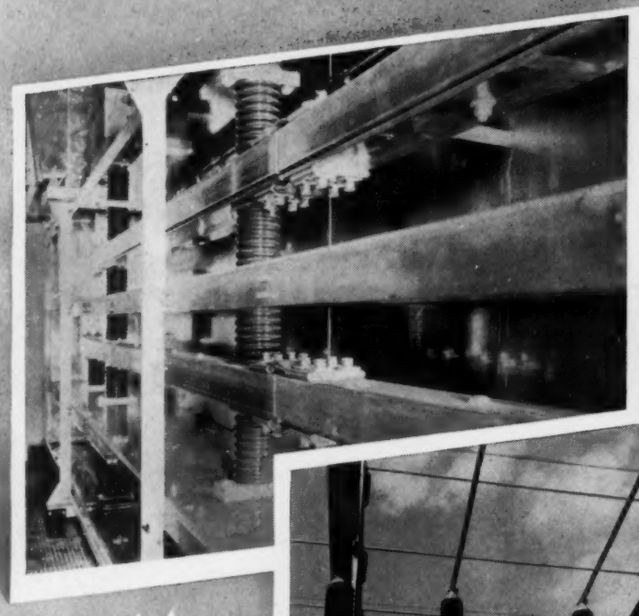
THE HIGHER THE PRESSURE
AIR
WATER
OIL
THE TIGHTER THE SEAL

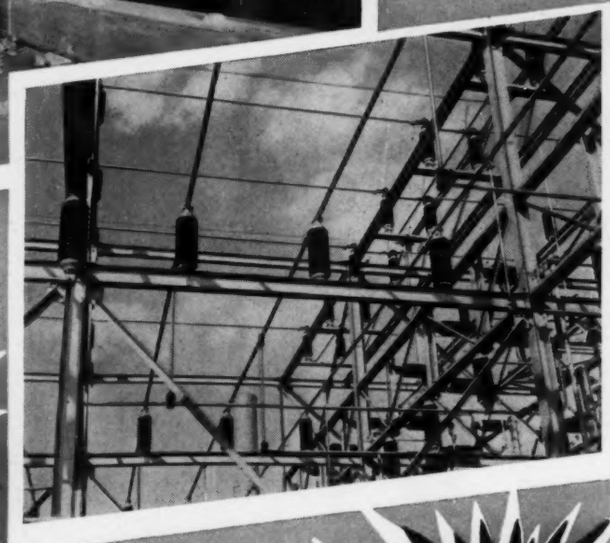
This is the Hunt valve-operated protective device that keeps operator's hands clear of the tooling zone. Lever S insures safe spindle starting. Lever F starts and stops feed.

C-B-HUNT & SON, INC. SALEM, OHIO

Alcoa Aluminum Bus Bars

HAVE EVERYTHING YOU NEED





HIGH CONDUCTIVITY

PROMPT SHIPMENT

LIGHT WEIGHT

RESISTANCE TO CORROSION

No other bus conductors offer a combination of advantages equal to those of Alcoa Aluminum.

Able to deliver heavy electrical loads with a minimum of loss—Sizes available to handle any electrical load—Highly resistant to corrosive atmospheres, indoors and out—Light in weight, easily formed, are convenient to install.

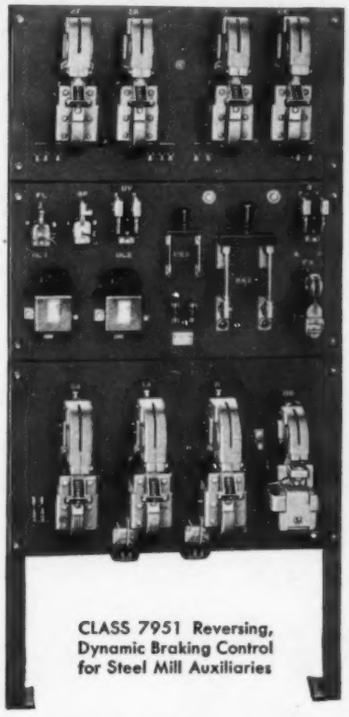
Alcoa Aluminum is available in all the shapes you'll need for that bus bar installation—flat bars, tubes, channels and angles. Fittings also.

Make that installation now with Alcoa Aluminum. No need to wait for hard-to-get materials. For prices and engineering data get in touch with the nearby Alcoa office. Or write ALUMINUM COMPANY OF AMERICA, 2128 Gulf Building, Pittsburgh 19, Pennsylvania.

ALCOA FIRST IN **ALUMINUM**

ALCOA ALUMINUM

CONTACTOR *Performance*



CLASS 7951 Reversing, Dynamic Braking Control for Steel Mill Auxiliaries

Another Reason for Specifying SQUARE D *Heavy-Duty D. C. Control for Mill Auxiliaries . . .*

SQUARE D Contactors are available with 8 hour ratings of 100, 150, 300 and 600 amperes and mill ratings 133% of those values. Normally closed contactors for dynamic braking have similar construction features.

Visit us at the Iron and Steel Exposition · Booths 73-75

Strong blowout coils, in combination with chimney type arc barriers, give high rupturing capacity and long contact tip life.

Heavy copper contacts are backed up by substantial supports which relieve the studs of impact and conduct away heat dissipated in the arc. Ample wear allowance provided without adjustment.

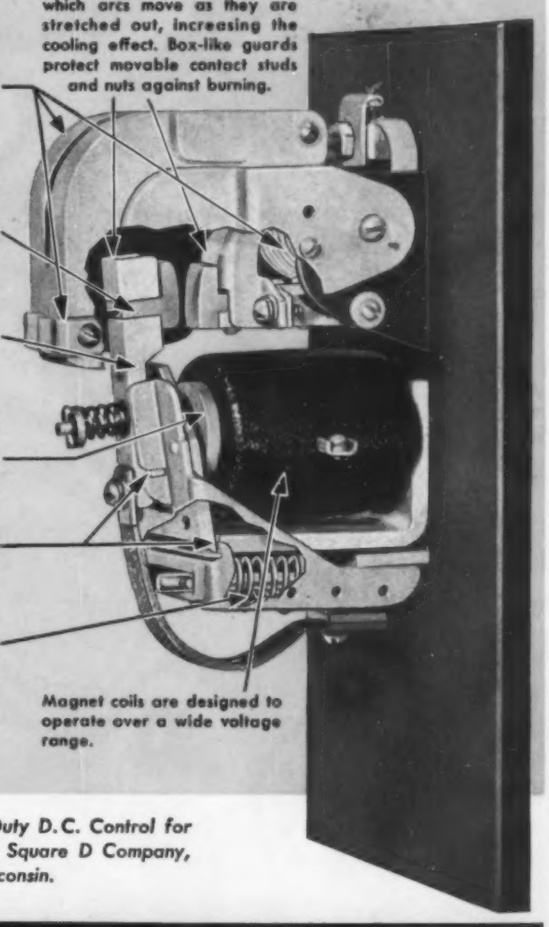
Extruded fingers provide ample current-carrying capacity without excessive inertia. Contact "bounce" is minimized.

Laminated magnet cores avoid the effect of residual magnetism without reducing mechanical life.

Knife-edge bearings are provided for both armature and finger. Wear is immediately taken up by the spring pressure applied to hold the knife-edge to its seat.

Opening speeds are increased, and accidental closing from vibration or sway prevented, by means of easily adjusted return springs.

Arcing horns provide paths over which arcs move as they are stretched out, increasing the cooling effect. Box-like guards protect movable contact studs and nuts against burning.



Magnet coils are designed to operate over a wide voltage range.

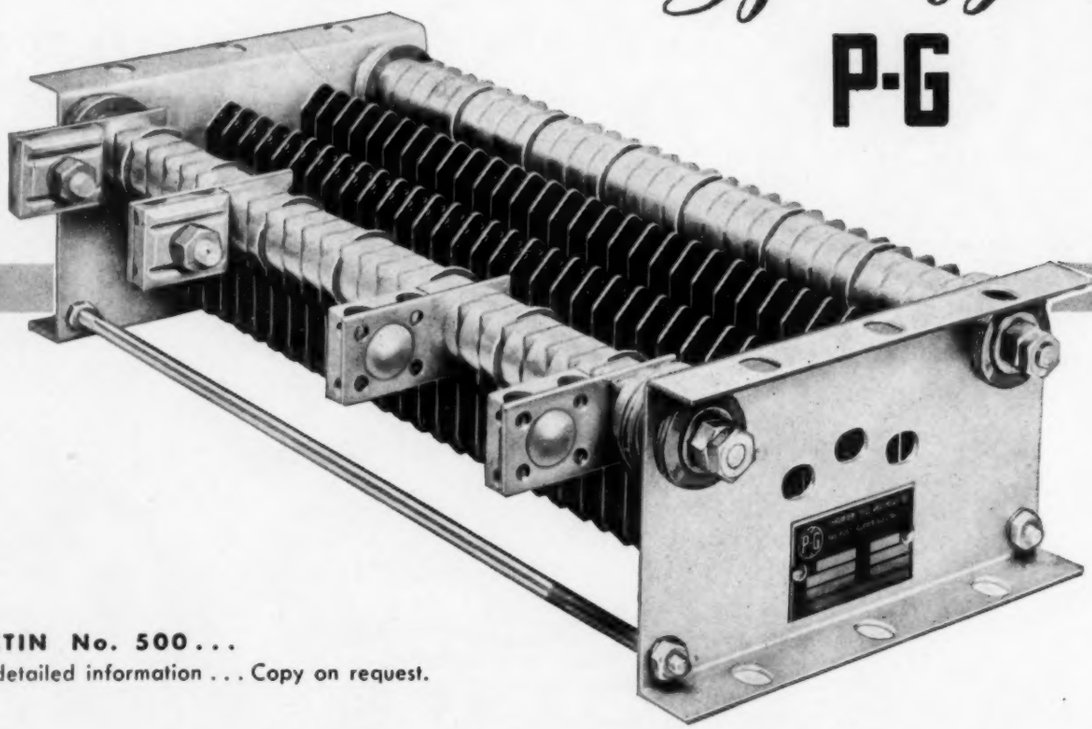
Write for information on the CLASS 7950 SERIES Heavy Duty D.C. Control for cranes and mill auxiliaries and CLASS 9003 Master Switches. Square D Company, 4041 N. Richards St., Milwaukee 12, Wisconsin.

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

for any job...

WHERE CONSTANT "TROUBLE-FREE" RESISTOR SERVICE IS ESSENTIAL..... *Specify* **P-G**



BULLETIN No. 500...
Gives detailed information . . . Copy on request.

Use of alloy steel and mica insulation, coupled with exclusive features of design, make P-G Resistors capable of constant "trouble-free" service. Specify P-G for maximum production with minimum maintenance.

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

•ESTABLISHED 1892•

221 WEST THIRD STREET, CINCINNATI 2, OHIO

You'll be ahead with

MORGAN WORCESTER

It's the same old question: How to maintain a fair rate of earnings in the face of rising costs and the pressure to keep prices down.

Morgan has helped rolling mill operators meet it time and again . . . with new ideas, new methods, new equipment.

We are ready today to discuss your plans and show how *you'll* be ahead with Morgan-Worcester.

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WORCESTER, MASSACHUSETTS

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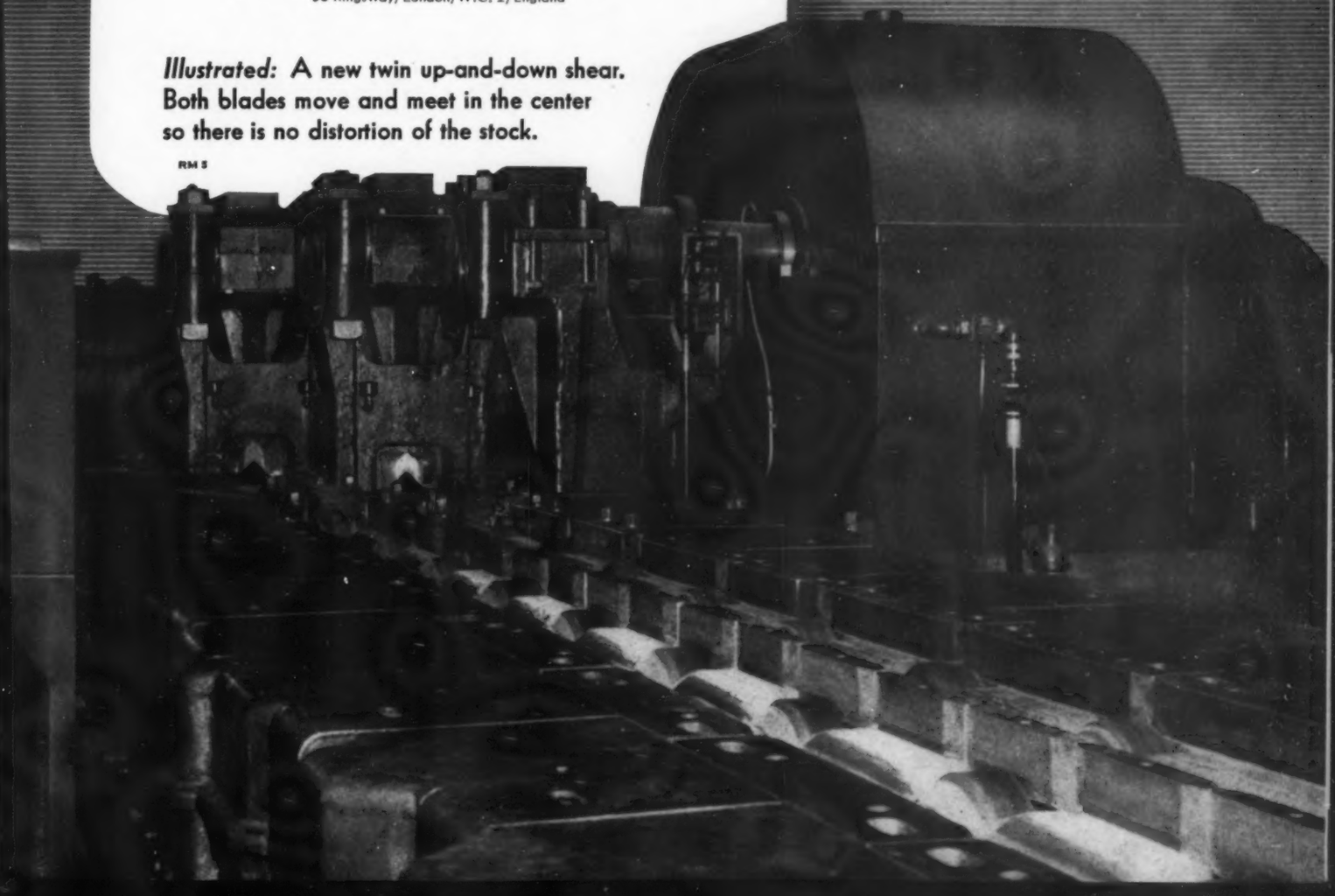
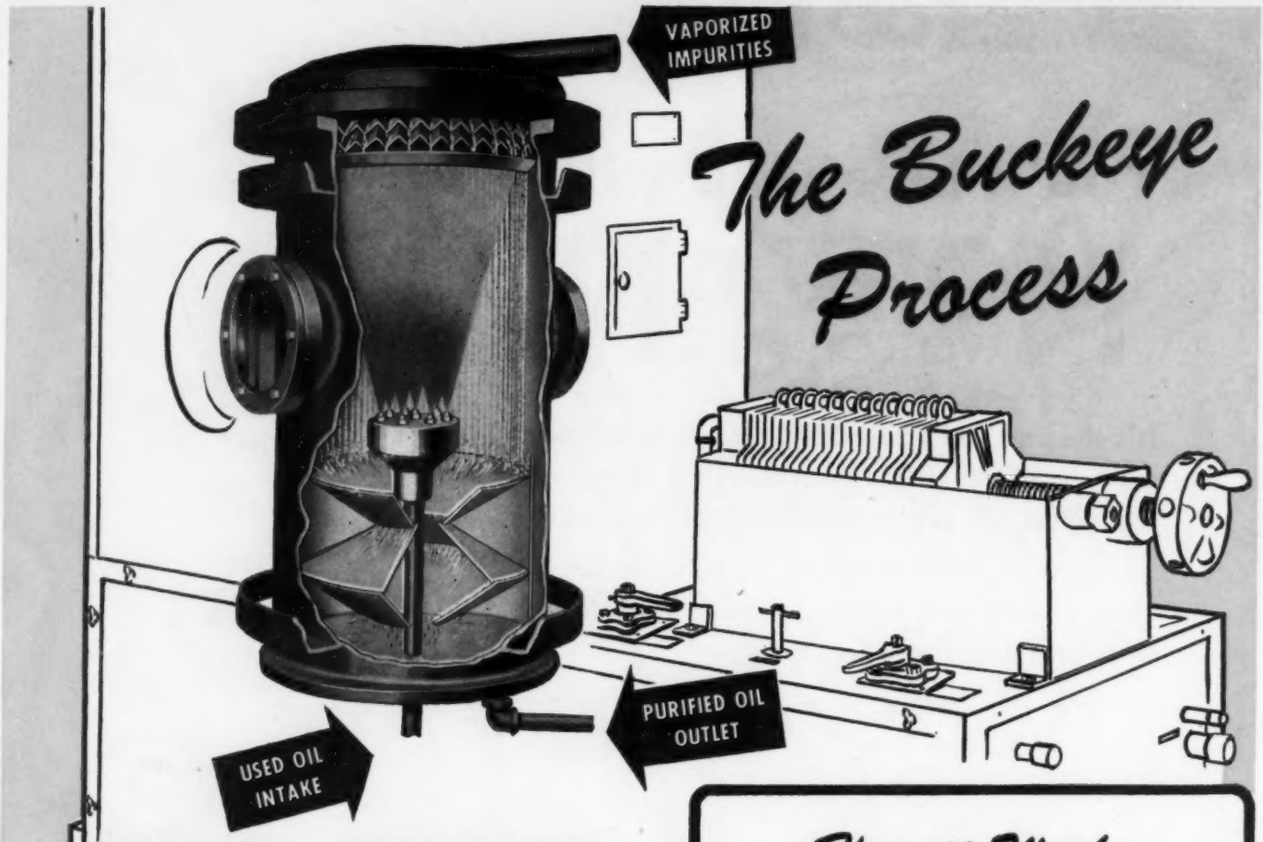
56 Kingsway, London, W.C. 2, England

Illustrated: A new twin up-and-down shear. Both blades move and meet in the center so there is no distortion of the stock.

RM 5





The Buckeye Process

BRINGS EFFECTIVE "Preventive Maintenance" TO OILS

The whole problem of successfully cleaning and stabilizing oil depends upon just TWO SIMPLE STEPS:

1—"Atomizing" the oil into minute particles to make easy the separation of water, gases and volatile acids.

2—Performing Step 1 in a vacuum, not only to separate the deteriorating elements from the oil, but also to prevent the re-entry of these "enemies" into the oil.

These are the fundamental reasons why Buckeye Processed oil greatly surpasses its original insulating values, has greater stability and offers a stronger resistance to sludging and to emulsifying.

Bulletin 100 gives full details about the Process; and cites brief case histories of its success not only with insulating oil, but also with lubricating and vacuum oils. Get your copy of this new bulletin by returning the coupon.

How it Works

1—Oil is supplied through a high-pressure pump to the "atomizing" nozzles.

2—Under a pressure of 120psi, the oil is forced into the properly heated Vacuum Chamber.

3—In the sealed Vacuum Chamber, the boiling points of the volatile impurities are greatly reduced. Presentation of oil in extremely small particles to the separating action of the vacuum accounts for the high efficiency and speed of the Buckeye Process.

4—The top baffles permit passage of the vaporized impurities to the vacuum exhaust; and direct the flow of the completely dehydrated and volatile-free oil to the bottom of the Chamber.

THERE ARE NO MOVING PARTS . .

NOTHING TO GET OUT OF ORDER

OR TO CLEAN

Get the facts

BUCKEYE

LABORATORIES CORP.

6708 Morgan Avenue

Cleveland 4, Ohio

BUCKEYE LABORATORIES CORPORATION
6708 Morgan Ave., Cleveland 4, Ohio

Gentlemen:
Please send me a copy of your new Bulletin 100 **A**

Name.....

Company.....

Street.....

City.....State.....

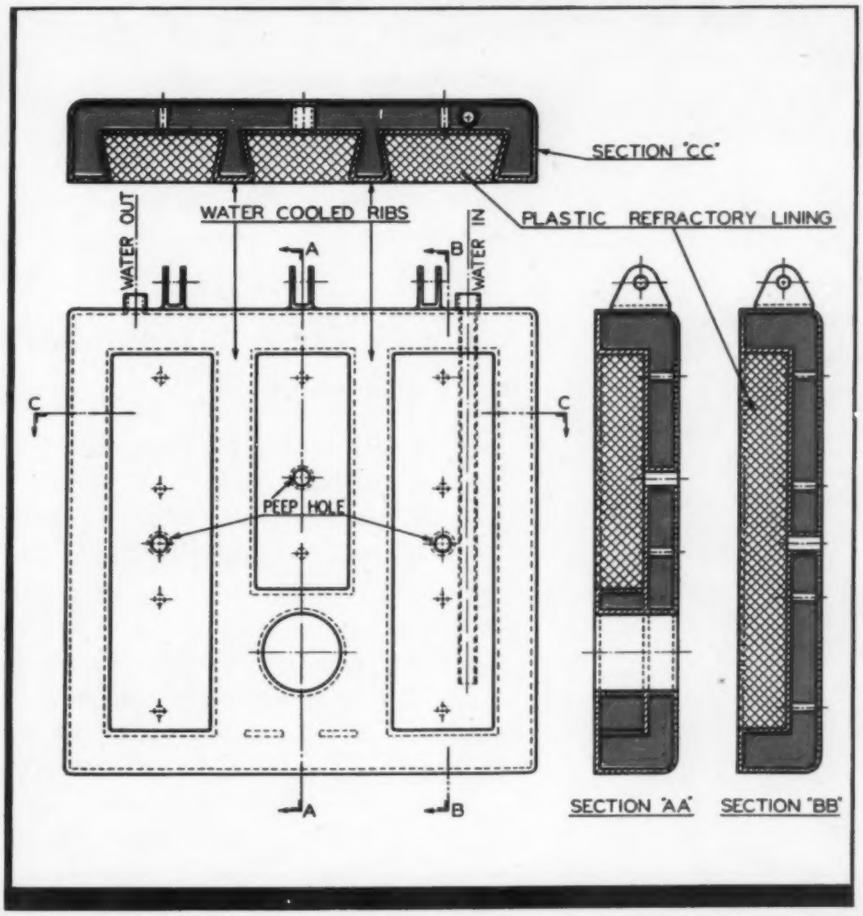
BAILEY J. F. STICKER TYPE

Patent Pending

WATER COOLED DOOR

for OPEN HEARTH and HEATING FURNACES

Water-cooled ribs divide the plastic refractory into easily cooled sections!



- **ARRANGEMENT OF RIBS ADDS STRENGTH TO DOOR —ELIMINATES WARPAGE.**
- **DOORS CAN BE LINED WITH PLASTIC REFRACTORY BY UNSKILLED WORKMEN.**
- **LONGER LIFE FOR DOOR AND LINING.**
- **DECREASED MAINTENANCE COST.**
- **INCREASED PRODUCTION AT LOWER COST.**

The Effectiveness of this Design has been Proved in an 11 Furnace Open Hearth Plant Equipped with Bailey Open Hearth Doors. The Life of the Refractory Linings Ranged from 150 to 200 Heats.

Manufactured in all sizes of open hearth and heating furnace doors. Send us your door drawings for quotations.

WILLIAM M. BAILEY COMPANY · *Engineers* · PITTSBURGH 22, PA.

THE NEW G-E GAS-

Offers You...

These FIVE Important Advantages:

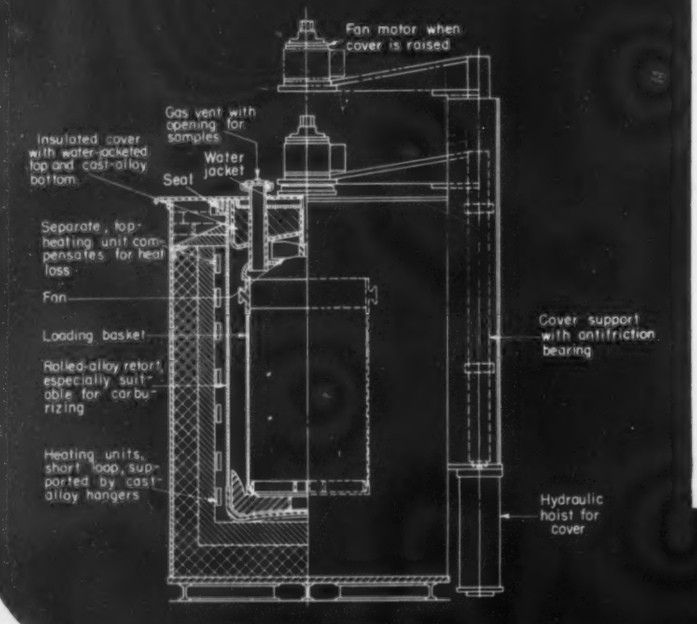
1. Uniform, Accurately Controlled Carburizing—With exact control of temperature, time at temperature, and gas distribution, the new, electrically heated G-E gas-carburizing furnace assures a uniform, high-quality output of carburized steel.

2. Short Carburizing Cycle—Accelerated heating by means of a high-powered furnace, and uniform heat distribution by a circulating fan, appreciably shorten the carburizing cycle.

3. Low Operating and Maintenance Costs—Using an inexpensive carburizing gas, having a short heating cycle, and requiring a minimum of material-handling operations—the new gas-carburizer is economical to operate. With a sturdy construction and a convenient arrangement of components, furnace maintenance is reduced and simplified.

4. Simple, Accessible Controls are conveniently provided on a single instrument panel.

5. Improved Working Conditions—With the elimination of solid carburizing compounds, working conditions are clean, and the general appearance of the heat-treating room is improved.

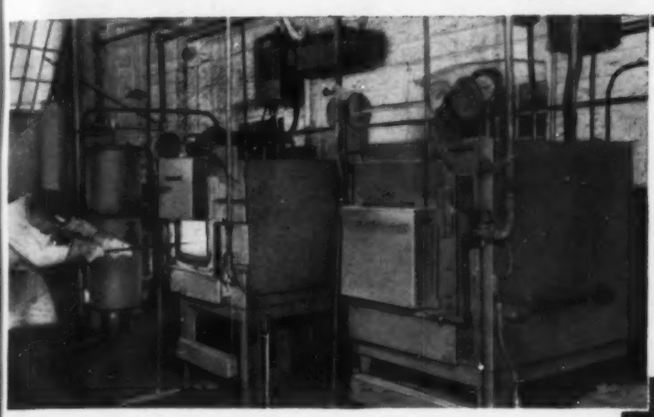

Fan motor when cover is raised
Gas vent with opening for samples
Water jacket
Seal
Insulated cover with water-jacketed top and cast-alloy bottom
Separate, top-heating unit compensates for heat loss
Fan
Loading basket
Rolled-alloy retort, especially suitable for carburizing
Heating units, short loop, supported by cast-alloy hangers
Cover support with antifriction bearing
Hydraulic hoist for cover

. . . And These Plus-dividends of Leadership:

- **Performance-proved Construction**
- **Technical Assistance**
- **Nationwide Field Service**

The new, standard gas-carburizing furnace, like all other G-E electric furnaces, assures you of performance-proved construction, based on steadily improved lines over almost a half-century of electric furnace research, design, and manufacture. To assist you in improving your product, experienced Heating Specialists are ready to help you to select your equipment and to recommend new, efficient techniques. And, in major cities throughout the country, an expert field organization is maintained to speed installations, solve operating problems, and to be readily available for servicing equipment.

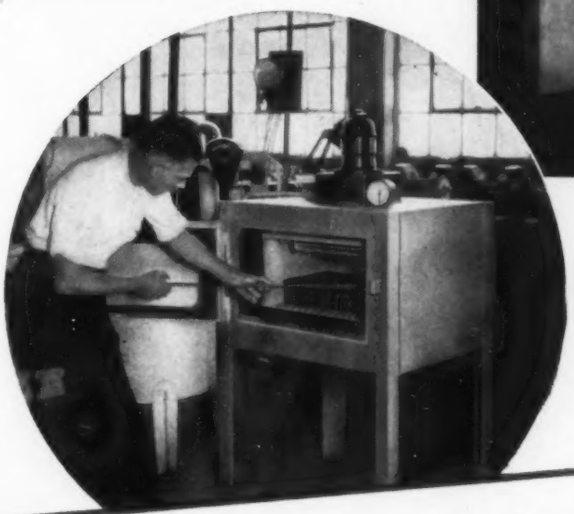
CARBURIZING FURNACE



Types "T" and "TG" high-temperature box furnaces, with protective atmosphere equipment, are used primarily for heat-treating high-speed steel without decarburization. With type "T" operating at 2000 F maximum, and type "TG" operating at 2500 F, these furnaces can also be used for miscellaneous high-temperature heating applications. Where decarburization and scaling are not factors, they may be used without atmosphere.

You reap the benefits of G-E "know-how" on these heating equipments, too . . .

In addition to gas-carburizing furnaces, G.E. builds specially designed and standard furnaces for virtually every type of heat-treating process. Here are a few of the standard models:



Pit furnace, with protective atmosphere, is used for heat-treating large gears, and for treating tubes and shafts which require suspension in the furnace to prevent warpage. Maximum operating temperature: 1850 F.

Air-draw box furnace—for drawing or tempering tools, dies, and other steel parts requiring accurate drawing temperatures up to 750 F. Standard models are also available up to 1250 F maximum.

For more detailed information on these furnaces, send us the coupon below. We will be glad to furnish you with *free*, descriptive bulletins.

In addition to furnaces, General Electric has also had wide experience in the development and construction of electronic induction, and dielectric heaters, and small heating devices, for a variety of applications. Our Heating Specialists and Application Engineers are prepared to recommend the electric heating equipment most suitable for your process. Call or write the nearest G-E Office.

General Electric Company
Apparatus Department, Sect. B675-140
Schenectady 5, N. Y.

Please send me bulletin GEA-3523B, "Gas-carburizing Electric Furnaces," and also the following (please check): ☐ GEA-3596A, "Type T Box Furnaces;" ☐ GEA-4065A, "Type TG Box Furnaces;" ☐ GEA-785C, "Air-draw Box Furnace;" ☐ GEA-4070, "Pit Furnaces."

Name .....

Company .....

Address .....

City ..... State .....

8784

GENERAL ELECTRIC

NEED STEEL?

Here's the way to get it

Scrap is needed to produce new steel. Millions of tons of steel products that have served their usefulness are idle—obsolete machines, structural shapes, pipe, old boilers and dozens of other awkward pieces.

Flame-cutting is a fast and economical way to reduce steel to pieces of the right size for charging into furnaces for the production of new steel. Line up a scrapping program *now*—we will be glad to help. Just call the nearest Linde office.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

DESIGNER AND BUILDER OF STEEL PLANT EQUIPMENT

O. H. FURNACES
CONVERTERS
CUPOLAS
MIXERS

from **BLAST FURNACE** *to*
INGOT POURING LADLE

INGOT CARS
SLAG CARS
H. M. CARS
LADLES

PENNSYLVANIA ENGINEERING WORKS
NEW CASTLE, PENNA.

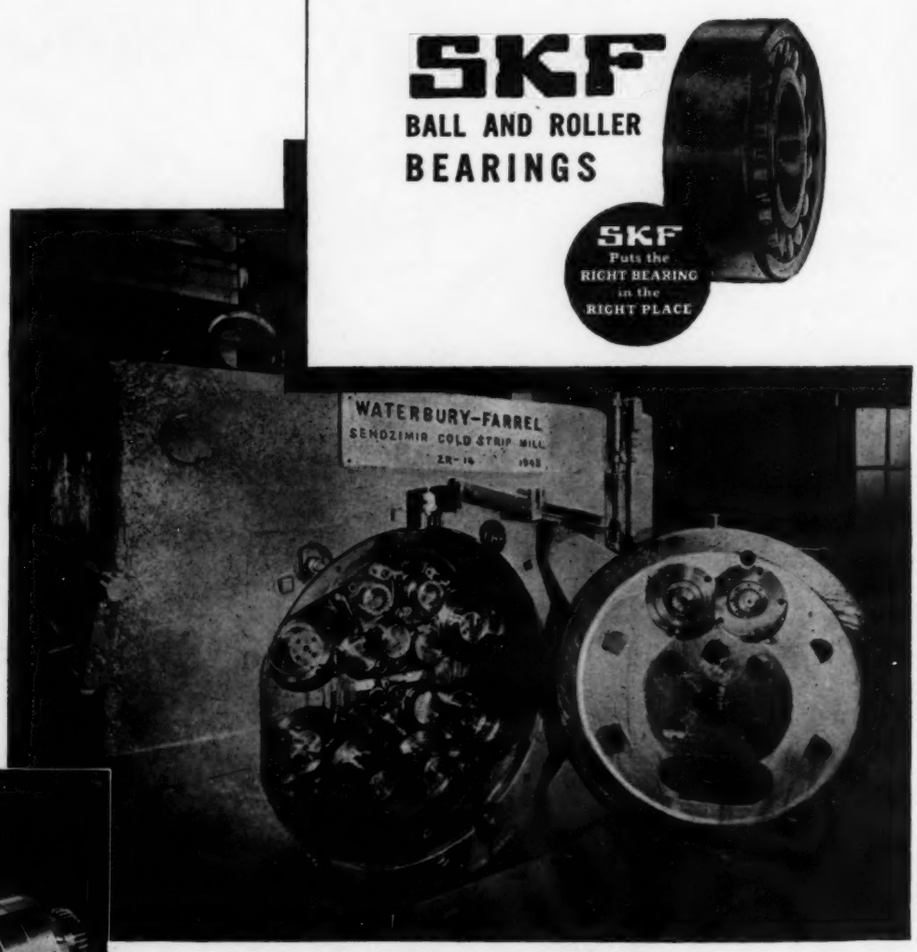
HEAVY LOADS REQUIRE MAXIMUM BEARING CAPACITY

Their *high load carrying capacity* makes SKF Spherical Roller Bearings "naturals" for this mill. It enables them to carry the tremendously heavy loads resulting from 70% reductions on light gage silicon steel. In addition, the *precision* of these bearings and the mill's rigidity means outstanding performance and continuous production of strip without crown or gage variation from end to end of coil. An SKF engineer can give you expert advice in selecting the right bearing for the right place. 6121

SKF INDUSTRIES, INC., PHILA. 34, PA.

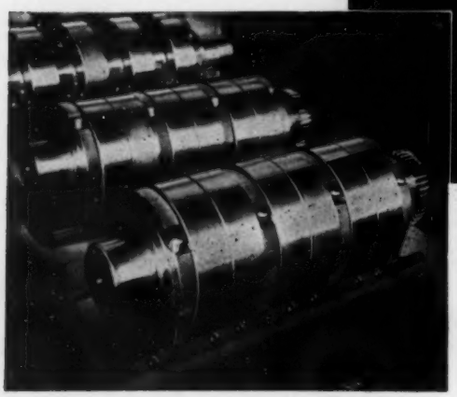
SKF
BALL AND ROLLER
BEARINGS

SKF
Puts the
RIGHT BEARING
in the
RIGHT PLACE



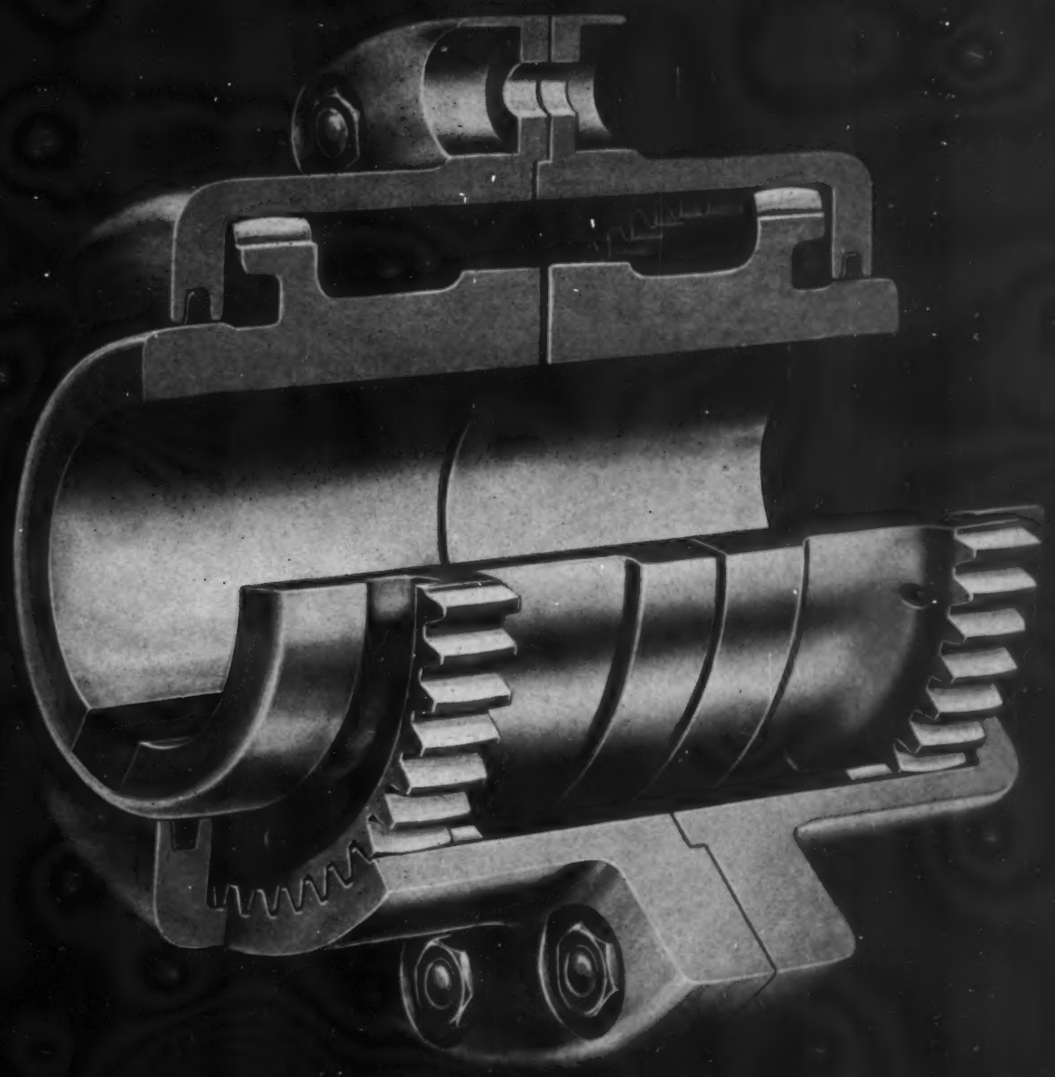
● SENDZIMIR COLD STRIP MILL — ZR14

Designed by Armzen & Co., built by Waterbury-Farrel Foundry & Machine Co., and operated by Armco, this mill is 100% SKF-equipped.



● *Six SKF Bearings per back-up roll shaft, four shafts per work—48 SKF's per mill.*

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

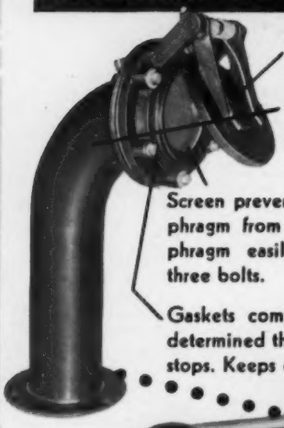
FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

Study the Top of a Pennsylvania Transformer for 60 Seconds

DEPENDABLE SAFETY VALVE PROTECTS TRANSFORMER FROM EXCESSIVE INTERNAL PRESSURES



Self-reclosing cover keeps out rain and foreign matter.

Curved shank of pipe prevents oil from discharging on top of transformer.

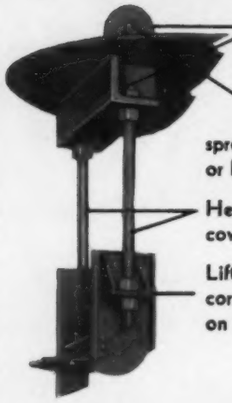
Screen prevents pieces of shattered diaphragm from entering transformer. Diaphragm easily replaced by removing three bolts.

Gaskets compressed and held to predetermined thickness by machined metal stops. Keeps diaphragm air and oil tight

A Transformer that is Tops in design and construction—that's what you'll note in the one minute study of this Pennsylvania Power Transformer. The examples are typical of the many fundamental improvements incorporated into all Pennsylvania Power Transformers.

20,000 KVA
44 KV
3 Phase
25 Cycles

SIMPLE, RUGGED ARRANGEMENT FOR LIFTING CORE, COILS, AND COVER



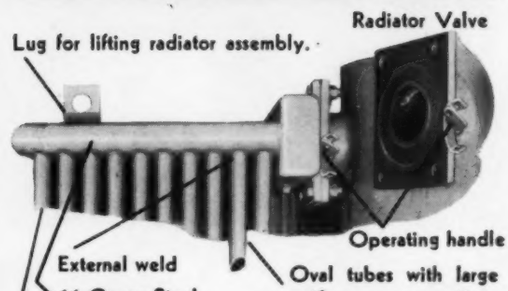
Lift lug brought through cover and welded to both sides of cover.

Removable pins permit use of spreader or slings equipped with hooks or links.

Heavy rods provide stable support for cover when unit is untanked.

Lifting force transmitted directly to core and coil assembly without strain on tank cover.

EACH TUBE OF DETACHABLE RADIATOR EASILY REACHED FOR CLEANING AND PAINTING



Lug for lifting radiator assembly.

Radiator Valve

Operating handle

External weld

11 Gauge Steel headers

13 Gauge tubes permit strong weld.

Oval tubes with large uniform cross section. Radiators tested at 100 lbs. per square inch.

Pennsylvania
TRANSFORMER COMPANY
808 RIDGE AVENUE, PITTSBURGH 12, PENNSYLVANIA

Pennsylvania TRANSFORMERS

LOOK TO THE FUSE LEADER FOR PRODUCTION PROGRESS

WARE HI-LAG *Renewable* FUSES

Only 3 PARTS

To Handle In Renewing Link

KNIFE-BLADE
250 VOLTS
600 VOLTS
70 to 600 AMPS.

FERRULE
250 VOLTS
600 VOLTS
3 to 60 AMPS.

APPROVED BY UNDERWRITERS LABORATORIES

WARE HI-LAG FUSE Construction establishes a top standard for rugged simplicity. There are only *3 PARTS* to handle to replace blown link:—the Fibre Case—the Knife-Blade Assembly—the Closure Ring. Only 1 wrench needed to loosen nuts and slip out blown link. Assembly can be inserted either end in Case.

Other exclusive WARE HI-LAG features which add to their cool operation—low resistance—dependability and long life service are, Large Double Contact Areas between Link and Blades—Steel Arched Lock Washers—Heavy Double Fibre Bridge—Gas Vents—Lateral Expansion Links.

Start using WARE HI-LAG Fuses today! Make them standard equipment for greatest satisfaction and economy. Investigate Now!

Write for Brochure giving details of all the COOL FACTS, sizes and prices.

WARE *Brothers* 4450 W. LAKE ST.·· CHICAGO 24, ILL.

EXIDE-IRONCLAD POWER MEANS *ALL-DAY-LONG* POWER

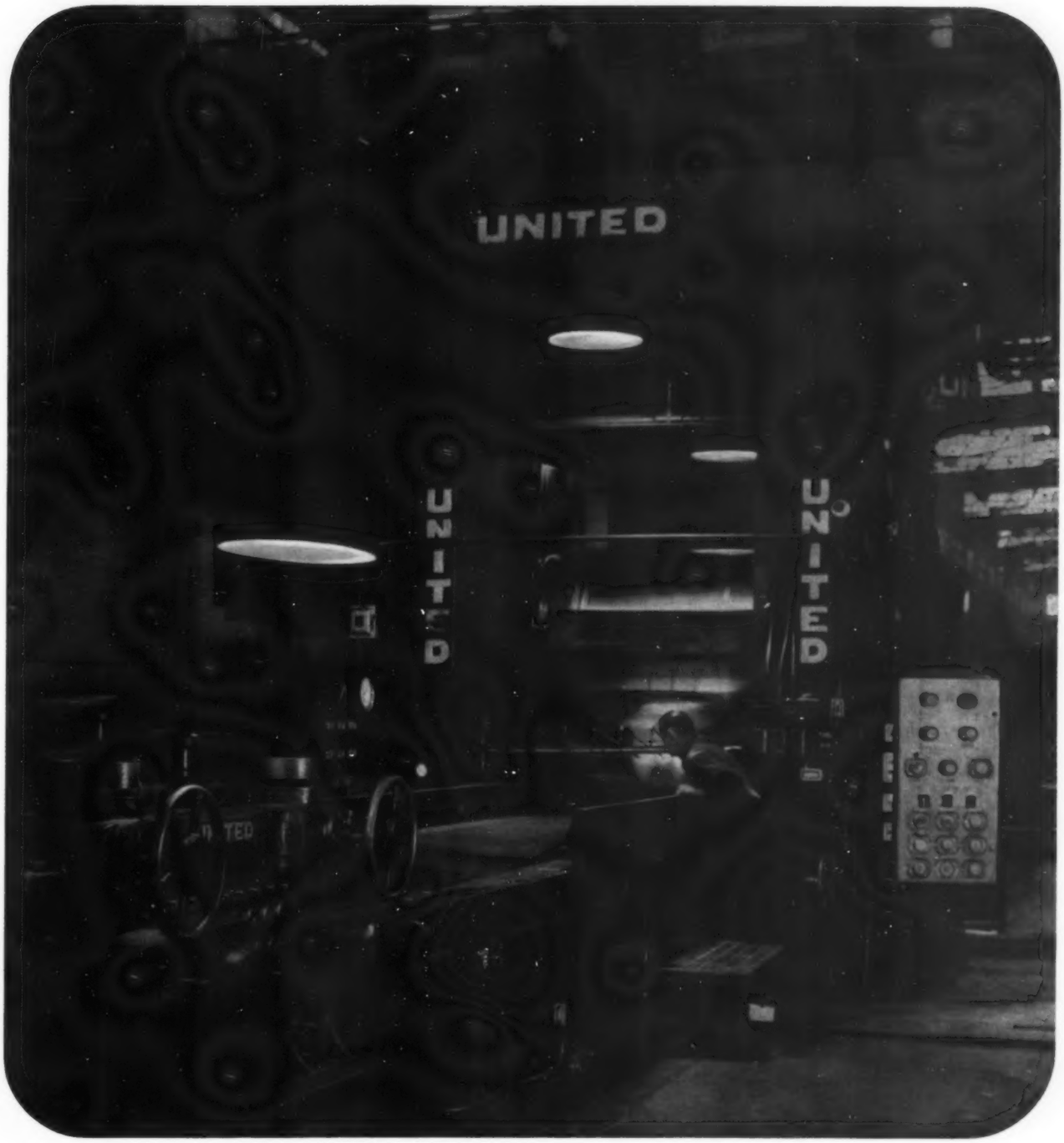
When your materials are handled by the efficient electric industrial truck—powered by Exide-Ironclads—you can always count on full shift availability. You can also count on faster, safer, easier handling and at a lower cost.

Exide-Ironclads have the *high power ability* needed for frequent "stop and go" service .... a *high maintained voltage* throughout discharge, assuring a uniform rate of operations . . . and a *high capacity* that delivers peak performance throughout the shift. And their rugged construction keeps Exide-Ironclads steadily on the job, serving with dependability, safety, long-life and ease of maintenance.

Write us for a FREE copy of Exide-Ironclad TOPICS which contains "Case Studies" of materials handling problems. Tells how to cut handling costs up to 90%... covers latest developments in handling materials from receiving to shipping.

THE ELECTRIC STORAGE BATTERY CO.
Philadelphia 32
Exide Batteries of Canada, Limited, Toronto

DEPENDABLE
POWER



UNITED 16" & 49" x 68"—4-High Sheet Mill

UNITED SHEET MILLS

UNITED mills of the type illustrated are widely used in the cold reduction of both ferrous and non-ferrous metals.

We are now building two similar mills for rolling stainless steel.

Designs of these new units are available for duplication; or they may be modified to suit your requirements.

Why not ask our engineers for further particulars.

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at Pittsburgh, Vandergrift, New Castle, Youngstown, Canton
Subsidiary: Adamson United Company, Akron, Ohio
Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q. Canada

★ The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment

Are Steel Executives looking far enough ahead —transportation-wise?

What gain using new-type Mill equipment—if savings are to be wasted in cross-handling your Steel through and between modern wide buildings?

You can *build up* savings all the way to delivery dock, using Elwell-Parkers engineered to your individual requirements — conventional Trucks and Cranes with suitable attachments, or original units engineered to your individual project—strips, sheet, plate, slab, or ingot.

Elwell-Parker's success in Steel is built upon years of cooperation with engineers throughout the industry — continually aiding with individual problems brought here for solution, gaining still broader experience for other Steel handling problems ahead. The Elwell-Parker Electric Company, 4504 St. Clair Avenue, Cleveland 14, Ohio.

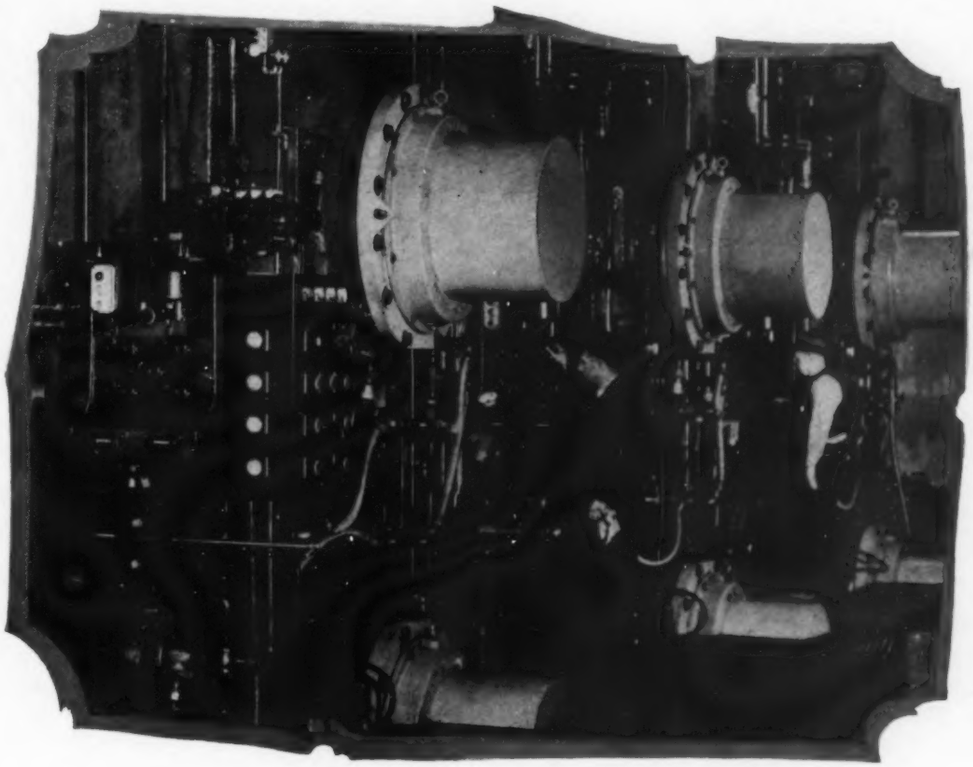
Please visit our Booth No. 94 at Cleveland, October 1, 2, 3 and 4.

ELWELL-PARKER

POWER INDUSTRIAL TRUCKS

Established 1893

"maintenance costs cut 20% ...since using Tycol E.P. Lubes"



"Nine years without a bearing failure . . . Lubrication costs cut 70% . . . No leakage at high temperatures . . . No bearing ever overheated . . . Service-life of equipment prolonged . . ."

These are a few of the reasons why Tycol Extreme Pressure Lubricants are acclaimed by engineers and operators as an answer to their lubrication problems. They know, too, that these performance-proved greases stand up in tough lubricating jobs . . . can "take it" indoors and out.

Your nearest Tide Water Associated Office will help you in the selection of that Tycol E.P. lubricant best suited for your particular needs. Call today.

TYCOL
INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C.
Pittsburgh • Philadelphia

TIDE WATER ASSOCIATED OIL COMPANY
17 BATTERY PLACE · NEW YORK 4, N. Y.

LUBRICATION—"ENGINEERED TO FIT THE JOB"

Spare Parts and Maintenance Problems Simplified

Recognizing the need for simplification in ordering and stocking Spare Parts for Electrical Control Apparatus, The Clark Controller Co. publishes very complete Spare Part Data Sheets. Shown first is a numbered picture of each part necessary to build the complete device—an exploded view of the apparatus. A complete description of each part is then given in a numerical list which corresponds with the numbers on the picture. The correct part number is also listed.

Parts recommended to stock—recommendations based upon indexing thousands of orders over many years—are indicated. Complete, detailed ordering instructions are given, as well as terms of sale.

There is no hunting for the name, number, or designation of the part you want. Simply locate the part on the picture, find the number in the numerical listing and read across the page.

MAINTENANCE AND INSTRUCTION SHEETS, giving helpful information for installation, adjustment and maintenance of "3C" apparatus have been compiled.

COIL DATA SHEETS giving complete "at-a-glance" information on voltage, cycle, poles and Bulletin number for every "3C" magnetically operated device, aid materially in selection of magnet coils.

The use of all these sheets (available to all users of Clark Control) simplify Installation, Adjustment, Maintenance, and spare part problems.

THE CLARK CONTROLLER CO.

1146 EAST 152nd ST., CLEVELAND 10, OHIO • EVERYTHING UNDER CONTROL

New LEADOLENE

THE *"I.P." LUBRICANT

FORGING COMPOUND

FOR { FERROUS AND NON-FERROUS METALS
TEMPERATURES 700° F. TO 2200° F.

● Increases Production, Tonnage

The NEW *LEADOLENE Forging Compound literally goes through "Hell and High Water"—*heat will not burn it off—water will not wash it off*—stickers are reduced to a minimum, for these easily understood reasons die life, tonnage and production are greatly increased.

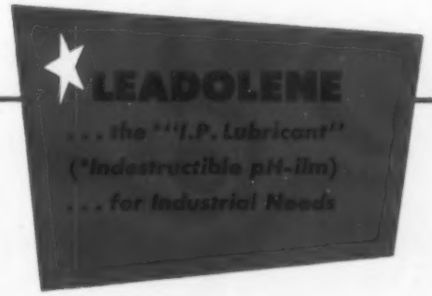
● Provides Safety for Workmen

The NEW *LEADOLENE Forging Compound is pharmaceutically pure-heavy flash and black smoke that seriously affect the pulmonary tract is practically eliminated—neither are there any harmful ingredients that will affect the skin.

The Brooks Oil Co.

Pittsburgh 19, Pennsylvania
Cleveland, Ohio
Hamilton, Ontario

Warehouses: In Principal Industrial Cities



Write for Technical Bulletin

MIDVALOY STAINLESS BARS

Among the most widely useful of all stainless steels are the hardenable straight chromium types. Midvale has been making them regularly for many applications. Bars in this category produced at Midvale include low and high carbon varieties in both free-machining and non-free-machining grades. Available in hot or cold finished form, most types are carried in stock in the popular sizes, shapes and finishes.

THE MIDVALE COMPANY • NICETOWN • PHILADELPHIA

OFFICES: NEW YORK • CHICAGO • PITTSBURGH
WASHINGTON • CLEVELAND • SAN FRANCISCO

STAINLESS AND TOOL STEEL BARS

•

CORROSION AND HEAT RESISTING CASTINGS

•

FORGINGS AND RINGS

MIDVALE

Custom Steel Makers to Industry

· IN ROLLING MILL PRACTICE

● Much of the rolling mill equipment in use today is outdated. The mills operate too slowly, cannot take heavy reductions, are not capable of precision rolling or require excessive upkeep.

Arms-Franklin has brought together experienced engineers who recognize the necessity for modernization. They have the ability to design and build equipment for greater production, precision rolling and lower tonnage costs. Consult them on your needs and plans for economical production. They want to help you.

THE ARMS-FRANKLIN CORPORATION

YOUNGSTOWN 3, OHIO

The ability which won the Army-Navy "E" and four stars is now available to American industry.

ENGINEERS AND BUILDERS OF ROLLING MILL MACHINERY

Subsidiary company:
TAYLOR-WILSON Mfg. Co., Pittsburgh, Pa.
Manufacturers of Tube Mill Machinery

"TOOL STEEL" PROCESS

PRODUCTS *are* GUARANTEED TO LAST LONGER

SCREW DOWN SCREWS AND NUTS

SPINDLES AND COUPLING BOXES

GEARS . . . PINIONS . . . PINS

TRACK WHEELS . . . BRAKE WHEELS

SHEAVE WHEELS . . . SHEAVE PINS

CONVEYOR WHEELS . . . SPROCKETS

COLD ROLLING ROLLS . . . SHAFTS

AXLES AND PINS . . . MILL PINIONS

COLD PROCESSING ROLLS

CLUTCHES AND CAMS

All Hardened Products manufactured under the "TOOL STEEL" Process carry a **Written Guarantee to give longer life than other products used in the same service.**

"TOOL STEEL" PROCESS PRODUCTS FULLFILL THEIR GUARANTEE

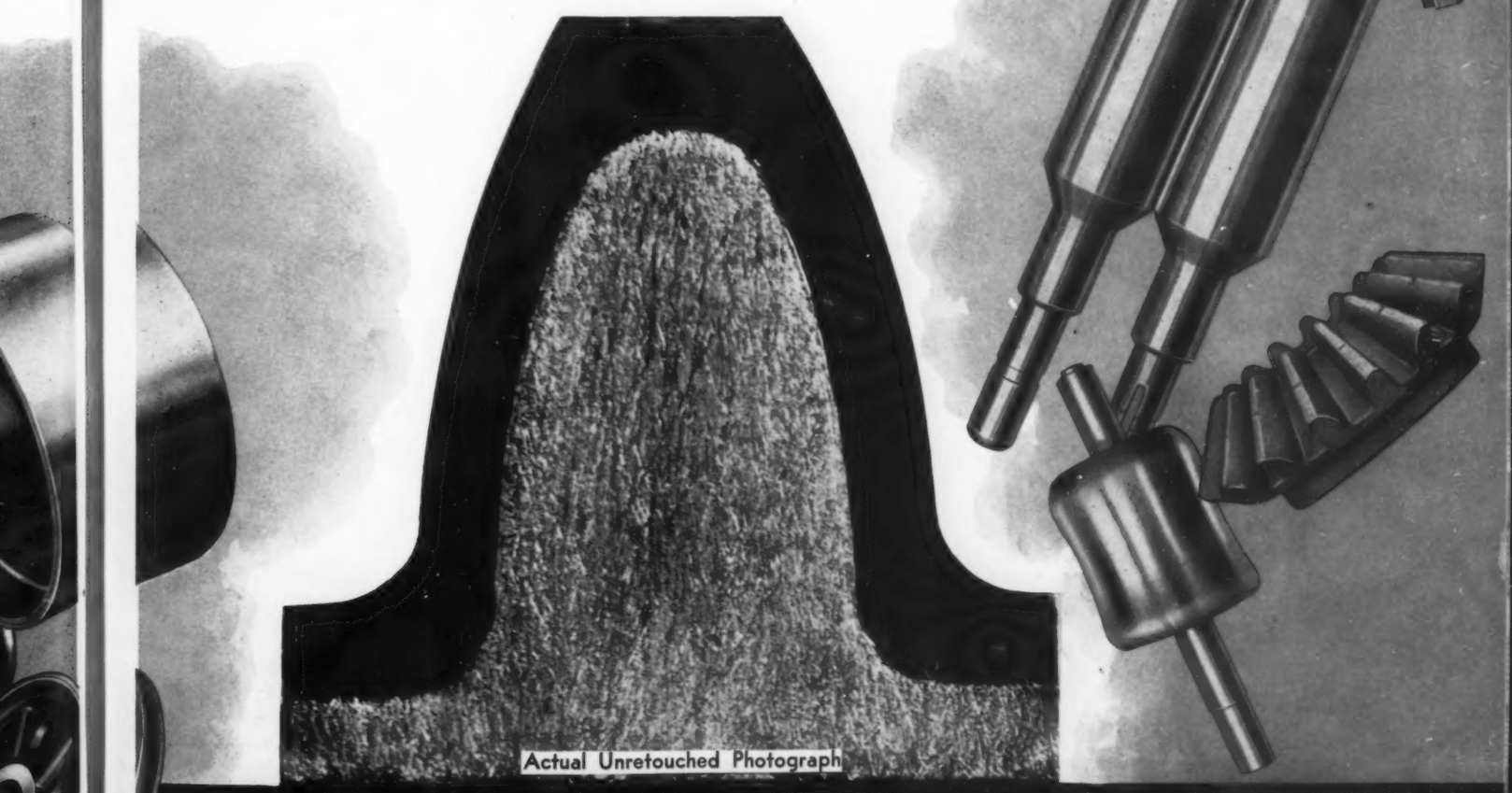
Because...

every product is carefully hardened and processed individually to meet its exact service requirements. Our 39 years of experience in furnishing and hardening all types of products for the most severe services of all heavy industry gives us the background to meet any of industry's problems.

Consult Our Engineers For Recommendations

Fully hard "Tool Steel" Process wearing surface, 650 to 700 Brinnel (85 to 95 Scleroscope). File hard to depth of 1/6 the distance on each side at the pitch line.

Core is treated for full refinement, toughness and ductility, 200 to 250 Brinnel (30 to 35 Scleroscope).



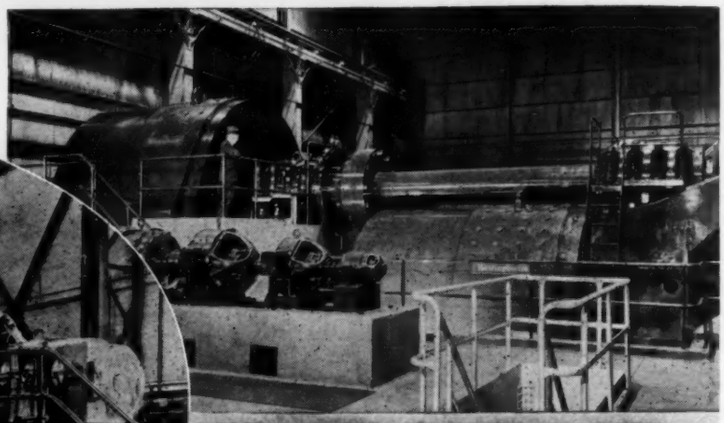
Actual Unretouched Photograph

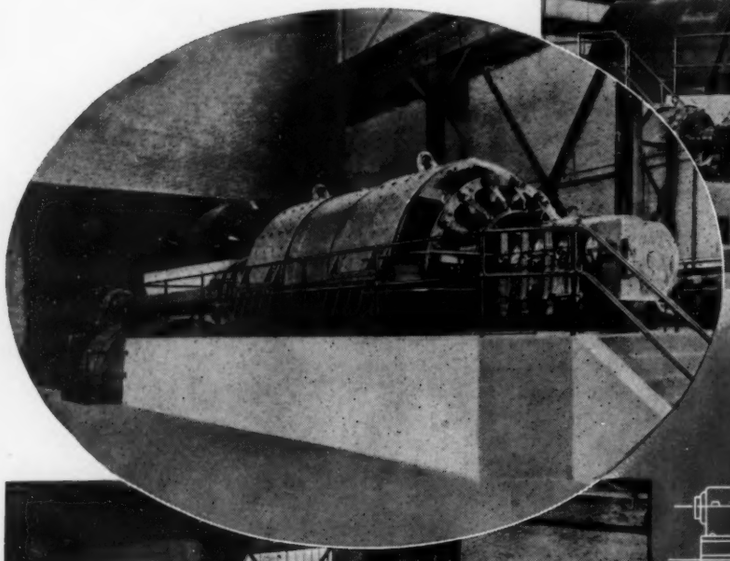
THE TOOL STEEL GEAR & PINION COMPANY

CINCINNATI 16, OHIO

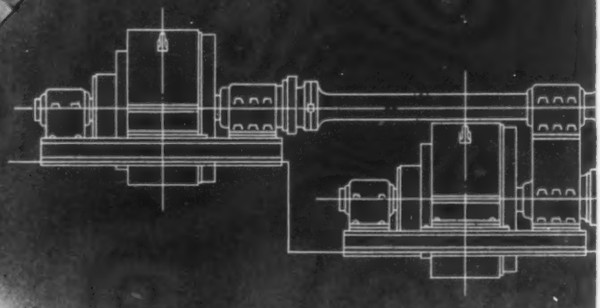
Westinghouse

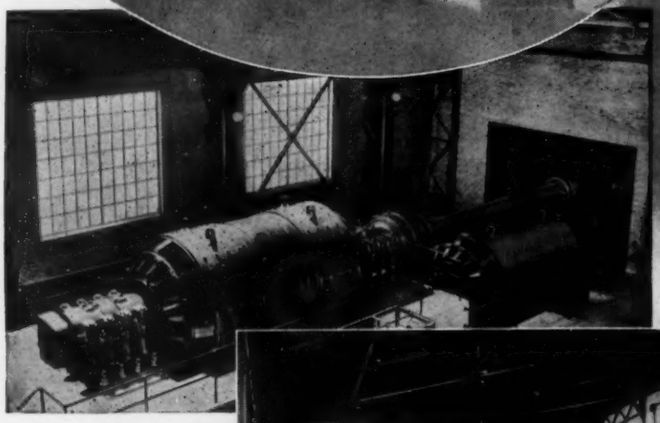
10,000 hp Twin-Motor Double Armature Installation in a *Slab Mill.*



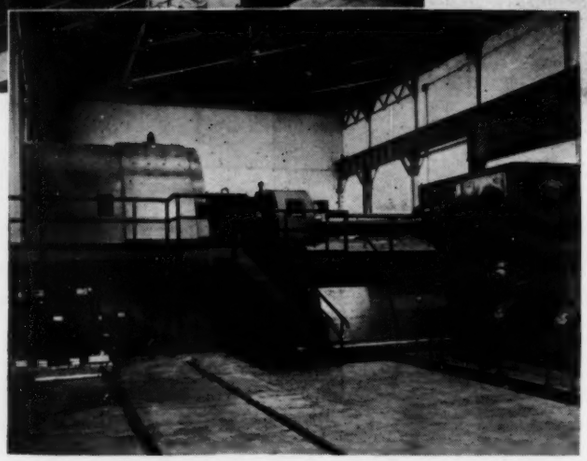


10,000 hp Twin-Motor Single Armature Installation in a *Slab Mill.*





10,000 hp Twin-Motor Double Armature Installation in a *Beam Mill.*



10,000 hp Twin-Motor Single Armature Installation in a *Slab Mill.*

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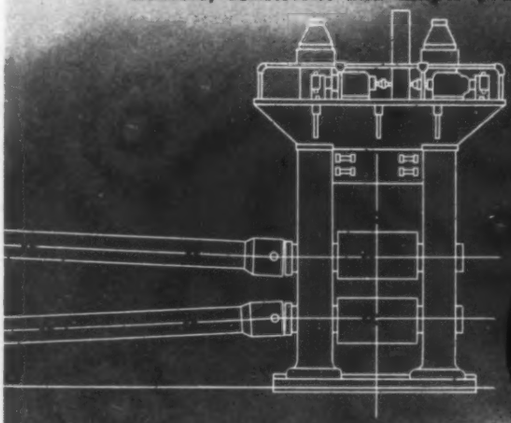
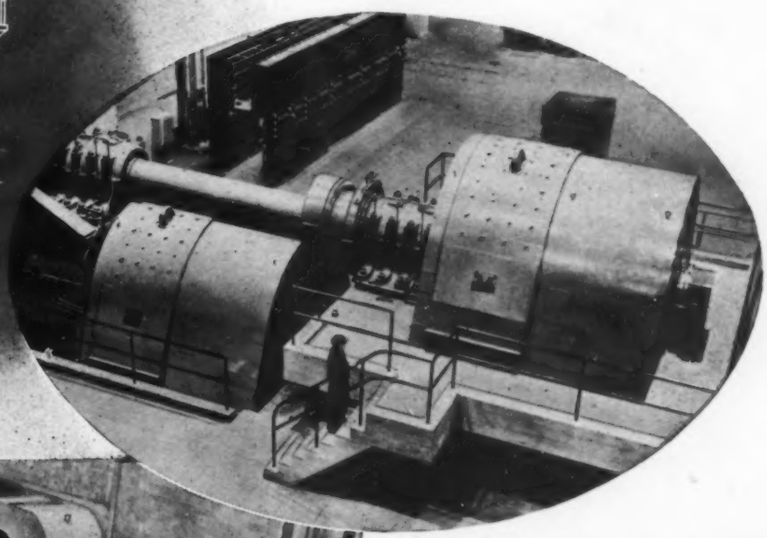
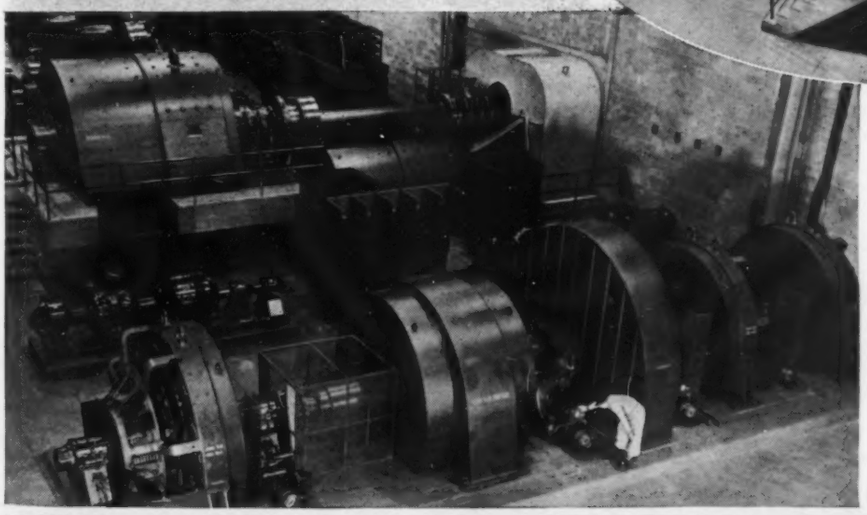


10,000 hp Twin-Motor Single Armature Installation in a *Plate Mill.*





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OTHER APPLICATIONS OF THE TWIN-MOTOR DRIVE

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- Main Drives . . . Skin Pass Mills
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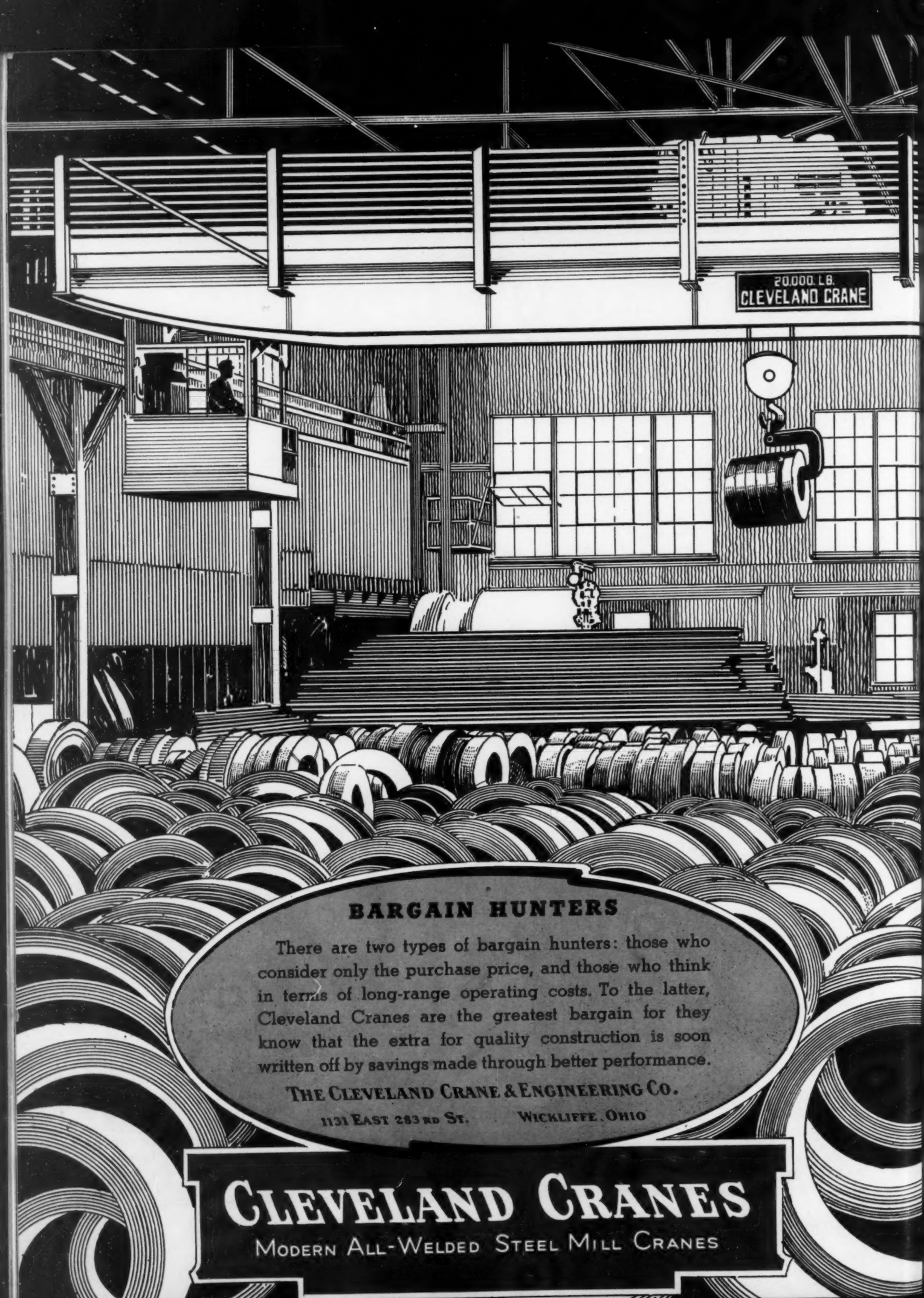

BARGAIN HUNTERS

There are two types of bargain hunters: those who consider only the purchase price, and those who think in terms of long-range operating costs. To the latter, Cleveland Cranes are the greatest bargain for they know that the extra for quality construction is soon written off by savings made through better performance.

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CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts

THE longest strike in the history of the steel industry came to an end on August 12 when 170 members of the International Association of Machinists at Granite City Steel Company were given an increase of 21 cents per hour instead of the 20 cents per hour offered by the company last March. The one cent increase will repay the machinists for pay lost during the strike in fifty-odd years — and the 1600 steelworkers who struck in sympathy show a net loss averaging $1075 each.

▲

THE wage-price situation is rapidly turning into a parallel to the "which-came-first-the-chicken-or-the-egg" proposition. Labor feels that recent price increases entitle it to higher wages, and seems determined to set off a new wave of strikes unless prices are rolled back to levels at which subsidy payments are necessary. Certainly, a halt must come in the advance of wages and prices if we are to avoid the drastic penalties of inflation. Higher wages without higher prices can come only from increased productive capacity of each worker — and this capacity is actually dropping.

▲

THE same insatiable appetite to get something for nothing which pervades us domestically is evident in the squabbles of peace conference delegates in Paris. The spirit of cooperation may not be dead, but is rapidly becoming buried in the slime of greed and selfishness.

▲

THE ex-GIs won't believe it but a survey by the New York Times reveals that Spam is the top-selling canned luncheon meat in New York markets.

▲

ANDREW CARNEGIE once observed "No man will make a great business who wants to do it all himself or to get all the credit for doing it."

▲

WE can't guess how many of our readers have read "The Hucksters," a recent novel dealing with radio advertising (and with the extra-curricular romantic activities of its central figure), but someone in the advertising business says "I want a job like the guy in 'The Hucksters' had." Advertising Age observes "For that one, son, you'll have to stand in line."

FROM The Employment Counselor: A man of mature years, wise in his experience of life, yet in want, had an abundance of time in which to meditate over his lot. His conclusions were summed up in the following regrets of "Things I wish I had known before I was twenty-one," a profitable admonition for young men:

What I was going to do for a living, and what my lifework would likely be.

That my health after thirty depended in a large degree on what I put into my stomach before I was twenty-one.

How to take care of money.

That a harvest depends upon seeds sown.

That you can't get something for nothing.

That the sweat of my brow would earn my bread.

That honesty is the only policy, not only in dealing with my neighbors, but also in dealing with myself and with God.

What it really meant to father and to mother to rear their son.

The greatness of the opportunity and joy of serving a fellow man.

▲

IT took Army psychologists years to find out what any truckdriver could have told them immediately — that some truckdrivers are more capable than many executives.

▲

ALTHOUGH you may not believe it until you count them, the average American home contains from six to a dozen fractional horsepower motors, used on furnaces, refrigerators, fans, vacuum cleaners, sewing machines, washing machines, electric clocks, kitchen mixers, ironers and phonographs.

▲

IRON ore stocks at furnace plants and at Lake Erie docks as of August 1st totaled 30,438,615 tons, enough for 4.7 months at current rates of operation. This stock is slightly above the corresponding figure last year — but there was no carrier's strike last year.

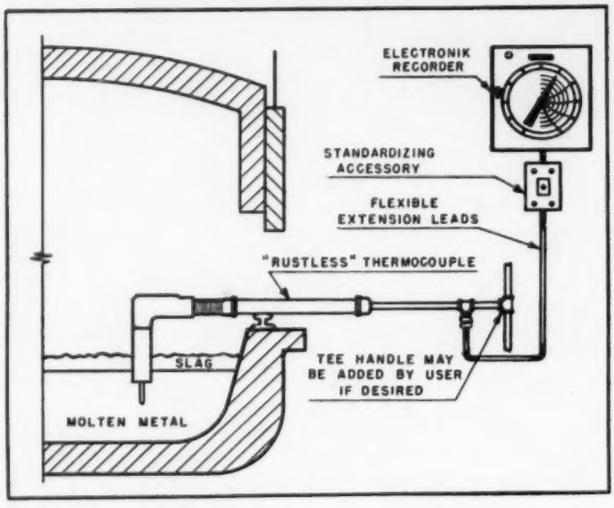
▲

SHEFFIELD Steel Corporation of Texas is awaiting government approval of its bid for the steel plant near Houston, Texas, before proceeding further with a $6,000,000 expansion program. Facilities at present consist of five open hearth furnaces, a blooming mill and a shell-forging plant. The expansion will include a new blast furnace and coke plant, two more open hearth furnaces and a wire mill.

▲

FOR the purpose of developing intelligent, responsible leadership among its local officials, the United Steelworkers of America recently held a "labor institute," lasting one week, at Antioch College, Yellow Springs, Ohio. This project is one of the first steps in a long range educational plan being developed by the CIO. Discussions included contracts, grievance procedure, promotion, layoff, rehiring, mediation, conciliation, arbitration, job evaluation, economics in industrial management, and economic effects within the steel industry — quite a formidable program for one week. Who was it that said "A little knowledge is a dangerous thing"?

Open Hearth "First Helpers"



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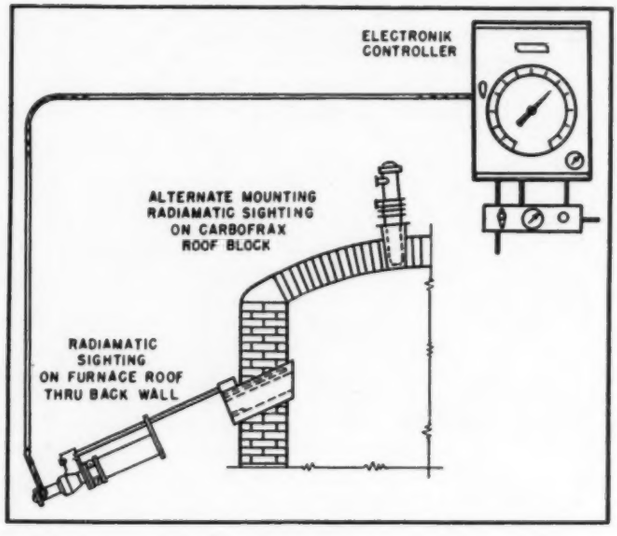
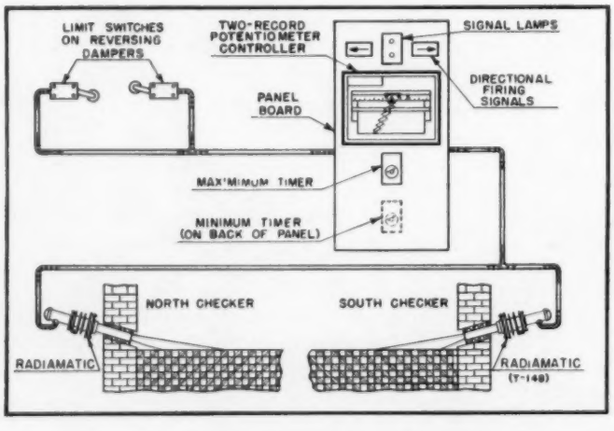
Brown Electronik Potentiometers provide speed and extreme accuracy in measuring bath temperatures by platinum thermocouple or air-purged sighting tube designs.

Roof Temperature and Fuel Flow Control Systems

Brown ElectroniK Potentiometers with Radiamatics protect roofs for longer life, while Brown Flow Meters and Controls maintain exact efficient firing rates.


ELECTRONIK CONTROLLER
ALTERNATE MOUNTING RADIAMATIC SIGHTING ON CARBOFRAX ROOF BLOCK
RADIAMATIC SIGHTING ON FURNACE ROOF THRU BACK WALL



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YESTERDAY

a Revolutionary Process!

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TODAY

What a Difference!

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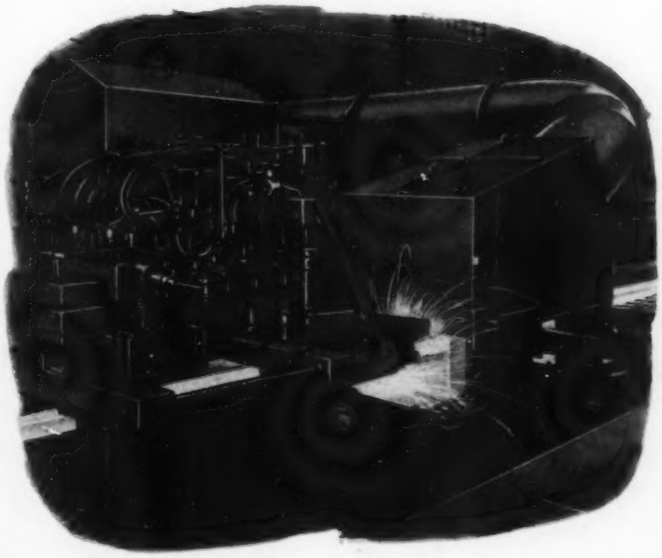

AND TOMORROW .....?

Airco's research and development staff will continue to work hand-in-hand with steel men to contribute new and better methods of steel production through the use of the oxyacetylene flame...creating the techniques and tools of tomorrow.

Airco's Technical Sales Division is at the call of steel men in applying Airco processes to the solution of their problems. For additional information, get in touch with your nearest Airco office or write: Air Reduction, General Offices, 60 East 42nd Street, New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, General Offices, Houston 1, Texas.

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The New WEAN WILSON
METHOD OF COIL STRIP STEEL ANNEALING

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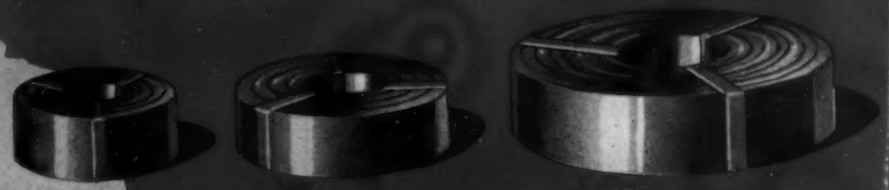
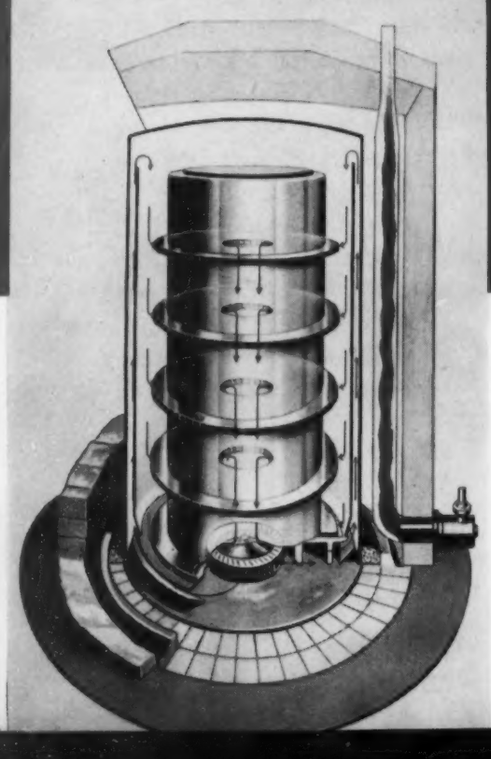
LARGER



And you want to pile the coils
HIGHER

Then heat them THIS WAY



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Iron and Steel ENGINEER

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In This Issue

Thermit Welding in Steel Plant Maintenance — by J. H. Deppeler, Chief Engineer, Metal and Thermit Corporation, New York, New York... 55
Protecting Mill Equipment with Hard-Facing — by G. E. Wilson, Service Engineer, Haynes Stellite Company, Kokomo, Indiana..... 63
Dynamic Balancing of Rotating Machines — by A. G. Gebhard, Master Mechanic, Illinois Central Railroad, Chicago, Illinois..... 68
Control of Vibration — by Alvin W. McKaig, Division Manager, Fabreeka Products Company, Philadelphia, Pennsylvania..... 70
Lighting Systems, Their Maintenance and Improvement — by Bernard P. Fantone, Carnegie-Illinois Steel Corporation, Gary, Indiana..... 77
Work Light for Steel Mills — by Davis H. Tuck, Chief Electrical Engineer, Holophane Company, Inc., New York, New York..... 80
Leather Packings for Hydraulic Roll Jacks — by R. W. Justice, E. F. Houghton and Company, Youngstown, Ohio..... 82
Applied Lubrication Symposium:
Applied Lubrication — by Maurice Reswick..... 85
Additives in Oils — by William P. Kuebler..... 89
Lubrication of Reciprocating Steam Engines and Steam Hammers — by F. C. Schoen..... 90
Standardization of Lubrication — by W. A. Smiley..... 92
Lubrication of Ball and Roller Bearings — by A. S. Murray..... 92
Extreme Pressure Lubricants in Steel Plants — by C. R. Hand..... 98
Centralized Lubrication Systems — by William M. Stilwell, Jr..... 98
A Sixty Ton Slab Turn-Over Device — by W. H. Burr, Superintendent, Electrical Department, Lukens Steel Company, Coatesville, Pennsylvania..... 100
Lukens Telescopic Stiff Leg Soaking Pit Crane — by John S. Morris, Project Engineer, Lukens Steel Company, Coatesville, Pennsylvania..... 102
Gear Ratios on Bridge Drives of Cranes — by H. H. Angel, Electrical Department, Bethlehem Steel Company, Sparrows Point, Maryland..... 106
A High Ampere Capacity Sliding Contact — by M. B. Antrim, Electrical Engineer, Lukens Steel Company, Coatesville, Pennsylvania..... 108
Some New Devices at Alan Wood — by J. W. Deimler, Electrical Engineer, Alan Wood Steel Company, Conshohocken, Pennsylvania..... 110
Maintenance of the Blast Furnace Cooling System — by G. Calder Little, Assistant Master Mechanic, Blast Furnace Dpartment, Bethlehem Steel Company, Sparrows Point, Maryland..... 112
Portable Tools Shortcut Steel Mill Maintenance — by G. D. Muschlitz, Assistant Master Mechanic, The Midvale Company, Philadelphia, Pennsylvania..... 114
The Reclamation of Precision Babbitt Bearings by the Gas Flame Method — by R. A. McCarthy, Master Mechanic, Rod and Wire Mills, Bethlehem Steel Company, Sparrows Point, Maryland..... 115
Equipment Installation Helps — by William A. Perry, Assistant General Superintendent, Inland Steel Company, East Chicago, Indiana..... 117
Electric Shop Practices — by H. R. Larson, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania..... 120
Abstracts of Papers to be presented AISE Annual Meeting..... 127
Official Program — AISE Annual Convention and Iron and Steel Exposition.....Following page 134
Announcement of New AISE Pittsburgh and Birmingham District Secretaries 179
News Supplement..... 143
Personnel News..... 171
Index to Advertisers..... 209

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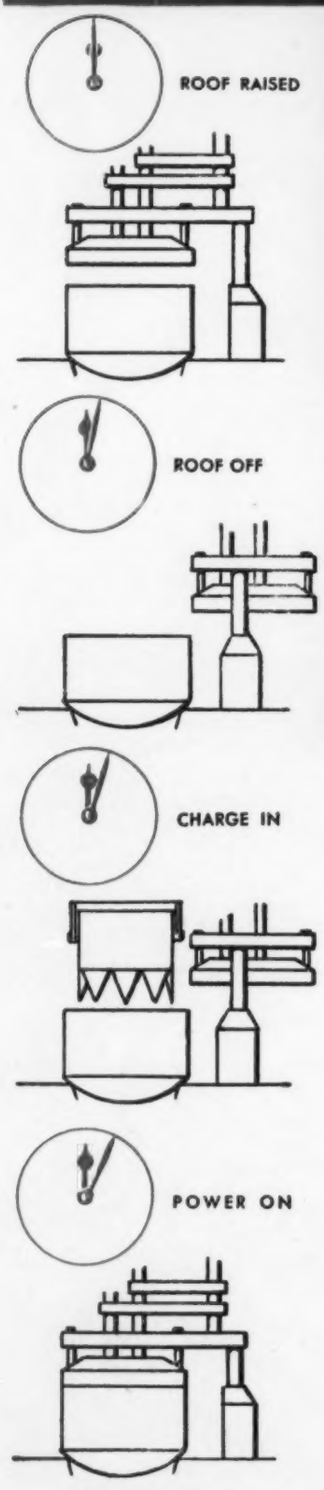

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THERMIT WELDING IN *Steel Plant Maintenance*

. . . . when a large machine part breaks, and cannot be readily replaced, the first thought is often welding . . . . the thermit process is widely used for such work, and a number of such applications are described by the author . . . .

by J. H. Deppeler

CHIEF ENGINEER

METAL AND THERMIT CORPORATION

NEW YORK, NEW YORK

▲ WITH the end of the second World War, it behooves all of us to look ahead to postwar production and its inevitable critical problem of economy. Thermit welding provides one way of economizing and a very practical way. Such welding can be especially valuable to a steel plant, because the welding process is so well suited to the fabricating and repair of very heavy machinery such as is employed in steel mills.

Among the many and varied successful jobs performed with the welding process in plant application, have been the welding of new necks on rolls and pinions; the building up of the worn wabbler ends of rolls and pinions; the repair of fractured mill housings, charging peels and shafts, and the welding in of new pinion teeth to replace teeth broken out in service.

Before continuing on the process and its many uses and ramifications, I would like to review the general procedure in making a thermit weld. To begin with, the basic factor in the process — the mixture — we can say, is a mixture of finely divided metallic aluminum and processed iron oxide, in roughly a one to three proportion. To this mechanical mixture is added manganese and carbon and, sometimes, nickel, molybdenum, chromium or vanadium.

When this combination is ignited, through the use of an ignition powder, the reaction which takes about thirty seconds, no matter how much of the mixture is involved, produces a temperature in the neighborhood of 5000 F or about twice the temperature of ordinary molten steel. In this reaction the aluminum combines with the oxygen of the iron oxide, becoming aluminum oxide, and the iron is set free in the form of superheated steel. The aluminum slag, being very light, floats to the top while the relatively heavy molten steel settles to the bottom of the crucible from which it can be poured as weld metal. Separation is complete, and most thermit steels contain less than 0.10 per cent aluminum.

The highly molten steel is released through the tapping hole of the crucible into a refractory mold

Presented before AISE Philadelphia Session of the Annual Meeting, October 6, 1945.

Figure 1 — Molten thermit steel flows from tapping hole of crucible into mold enclosing the beam which is to be welded.

Figure 2 — A wax pattern is formed in the gap. This pattern is the shape and size of the final weld metal.

which encloses the parts to be welded, as shown in Figure 1, melting and fusing with the parent metal to make one complete permanent part.

In preparing for a thermit weld, the first step is to line up the parts and to cut a parallel-sided gap with an oxyacetylene torch at the point where the weld is to be made. The width of the gap depends on the size of the section. In and around the gap, a wax pattern is made in the form to be taken by the thermit weld metal and such a pattern is shown in Figure 2. A mold box of sufficient size, designed to fit the section to be welded, is then applied.

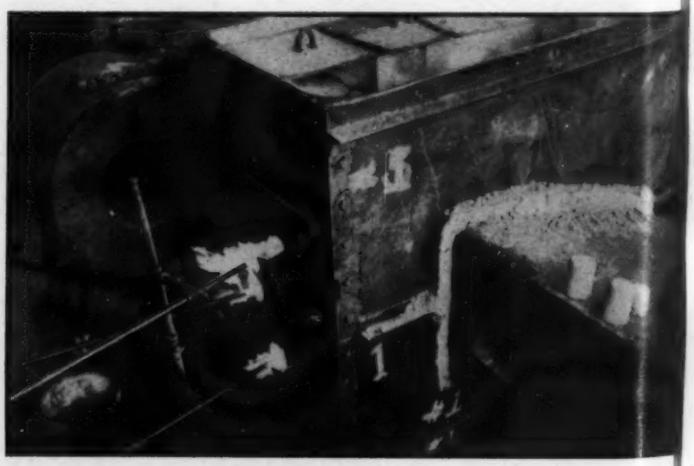
The next step is to ram the mold box with molding material. As the molding material is added, the various gates and riser patterns are placed in their proper positions. These patterns are removed after the ramming is completed.

Parts to be welded are then preheated by means of a specially designed preheater which burns kerosene atomized by compressed air. The preheating flame shown in Figure 3, is blown into the mold through the heating gate and simultaneously dries out the mold and heats the parts to a red heat. The refractory lined crucible filled with thermit and plugged at the bottom is supported over the pouring gate. A sketch of the complete setup is shown in Figure 4. The reaction is started by placing a small quantity of ignition powder on top of the thermit, igniting the powder by the flare of a match, or preferably with a red hot rod, and in about 30 seconds, when the reaction is over, the crucible is tapped, allowing the resultant molten steel to run into the mold and form the weld. With the excellent physical properties of the weld metal, which are sound and close-grained, and with proper allowance for shrinkage, the results are most dependable. The final weld is shown in Figure 5.

Since it is cast steel, a question may arise as to the quality and strength of the steel as compared with forged steel. This is an important query because, if the weld is considered to have only the strength of cast steel, its application in steel mills would be extremely limited. As a matter of fact, this is not the case, as has been proven many times in tests and in actual practice.

In a large number of tests, forgings that have been thermit welded and tested to destruction just as often fail completely outside of the welded area as they do in the weld or in the metal adjacent to the weld. We can account for this by theoretical deductions. Steel, as cast, differs from forged or worked steel, not in its chemical composition, but physically. This physical difference lies largely in the weakness of the grain boundary. Commercial cast steel, on solidifying, throws out to the grain boundaries a large number of impurities which form part of the cementing medium between the grains, and make this weaker than the grains themselves. For this reason, the fractures of cast steel are usually intergranular. Forging, rolling, or otherwise working these grains distorts them so that this grain boundary no longer is of importance, the strength of the piece being that of the material itself and not that of the weaker grain boundary. Thermit steels are produced by the reduction of a very pure iron oxide by an almost perfectly pure aluminum. Therefore, although cast, because they are relatively pure materials, a resultant steel similar to forged steel is produced without the necessity of refinement by working. Invariably the fractures on thermit steel are through the grains and not, as in the case of most cast steels, along the grain boundaries, so that the steel has all the properties of the forged steel except for its appearance under the

Figure 3 — Preheating flame is blown into the mold through a preheating gate. Fuel is atomized kerosene.



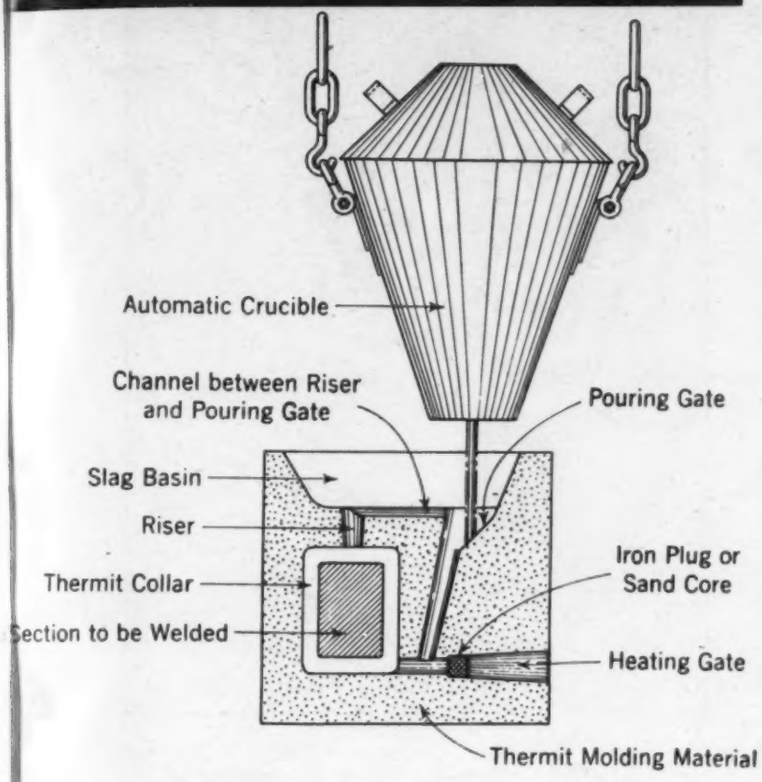


Figure 4 — Details are here shown of a set up prior to welding.

microscope. Whether this is the explanation or not, it is a fact that in every test and by actual service, such steels compare very favorably with the physical properties of the highest grade forgings.

A comparison between thermit and forged steels was conducted some years ago when Lloyd's Register of Shipping investigated thermit welding for use in ship stern frames.

Specimens tested for impact were 10-inch square sections about three feet long, thermit welded end to end. They were not annealed, and no work was done on them, except that excess weld metal was machined off. A six-foot long specimen, welded at mid-point, was supported horizontally on five-foot centers and a 3,290-pound pear-shaped weight was dropped directly on the weld from a height of 18 feet. In nine drops the test piece was deflected downwards $1\frac{7}{32}$ inches, with no sign of distress. It was then turned over 180 degrees on the assumption that it could easily be broken, if bent back. The drop testing continued, and after six drops the piece was practically straightened out, without indication of failing. This, and sundry other tests of welds in forged steels specified by Lloyd's, resulted in universal approval of thermit welding.

I should also like to point out that such welds are dense and sound because they solidify from the inside toward the outside. This is because the sections being welded act as enormous chills in the casting, and extract heat more rapidly from the center than from any other point.

Thermit steels may include various alloying elements, since these elements can be introduced by means of metallic pieces which are instantly melted in the reaction, or they may be introduced in the form of combinations of the oxide of the metallic elements with aluminum. The reaction efficiencies of many metallic oxides have been determined in a long and thorough series of experiments and, therefore, the analysis of the steel to be produced may be readily predetermined.

By such means, we have at our control the tensile strength, the ductility, and the hardness of the resulting steels. The tensile strength can be varied from about 50,000 pounds per square inch to 110,000, and the corresponding ductility from over 40 per cent elongation in two inches down to zero.

There are three principal jobs for the welding process in the mills: (1) the repair of broken parts, which may be indicated for economical reasons, or as a time-saving device to place the machine or mill back into production again; (2) the building-up of worn parts, which, in many instances, replaces the material worn off with one better suited to withstand the service; and (3) the most recent and promising development in the welding process, the manufacture of new constructions.

The fabrication of heavy parts with thermit welding is past the exploration and experimental stage, and Figure 6 illustrates a common application. By incorporating into the design of heavy units, simple forgings, small castings, or flame-cut shapes welded together, the cost of bulky pieces can often be reduced to a fraction of what it would be if large intricate castings were used.

In addition, the difficulties of obtaining sound metal where very large castings must be poured are eliminated. At the same time, many of the inherent delays of cast construction can be avoided and production can be effectively speeded. This is especially true where changes in design are involved, or entirely new units are to be constructed, since welded fabrication eliminates the costly, time-devouring task of making new patterns.

While many of these same advantages apply to welded fabrications involving other welding processes where

Figure 5 — After the mold is removed, the resultant weld is as shown in the illustration.

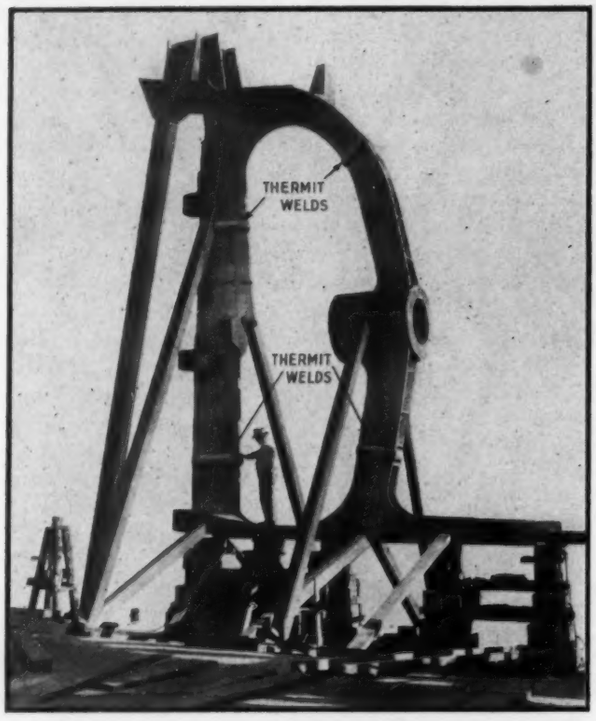


Figure 6 — This ship's stern frame has been assembled with four welds, thus reducing the size of the casting.

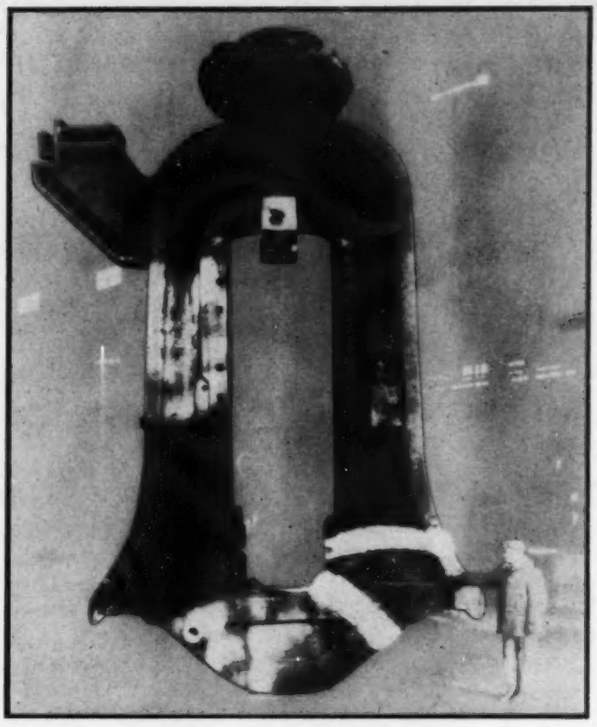


Figure 7 — This large mill housing was repaired in two places with thermit welds.

heavy sections are involved, the thermit process may be the only practical way. In the first place, preparation of parts for thermit welding is simpler than that required with other welding methods and usually may be accomplished by flame-cutting, eliminating the need for machining of intricate joint designs, which is always a slow, expensive procedure. Also, time required for our type welding, including the construction of molds and preheating, is always much less than that needed to deposit large quantities of weld metal layer by layer, in thin layers, as must be done in electric welding. In addition, a properly made thermit weld has no locked-in internal stresses and, therefore, stress-relieving (which would be mandatory in a heavy arc welded structure, but which might be out of the question because of the size) is unnecessary when our welding method is used. With electric welding, positioning of heavy welds also is often required to permit the employment of high quality, downhand welding rods, and very large structures are sometimes difficult to manipulate. With thermit welding, no change in position of the unit during welding is required.

Many interesting and enterprising examples of employment of thermit in the fabrication of heavy parts have been brought to my attention recently: a blooming mill pinion housing, 7 ft 10 in. high, 8 ft 9 in. wide, and weighing 22,500 pounds, built to replace a cast iron housing at the plant of the Andrews Steel Company, being among those cited. The central, load-bearing member of this pinion housing was flame-cut from eight inch plate in two "S" shaped pieces. These two pieces were then welded to make a large "U" shaped piece, 8 by 27 in. in cross-section of the weld. Caps, bases and stiffening members were then welded to the central section by means of arc welding. Welded construction provided a stronger, sturdier, but lighter weight unit than the original cast housing, and the welding of the central section was accomplished in much less time than would have been required for any other type of weld. Some idea of the enduring nature of this all-welded pinion housing may be gleaned from the fact that after a year's hard service, it was standing up perfectly, despite subjection frequently to unusual and excessive stresses. On more than one occasion, when too deep a draft was attempted on the blooming mill, the welded pinion housing was moved with sufficient force to snap the tie bolts holding it in place, yet examination showed no damage to the housing itself.

Another illustration of the employment of welding in the manufacture of heavy parts is that of seven large H-beams used to form the body of a huge freight car, 90 feet long, with a capacity of 25 tons, built for the Carnegie-Illinois Company by the Greenville Steel Company. Each of these beams is made up of five separate members, butt welded as shown in Figure 8 by means of the thermit process. The five members of each beam comprise the central drop platform piece, two transition pieces and two span bolster pieces. The central platform members are rolled beams, weighing 426 pounds per foot, while the span bolster members are rolled beams, weighing 164 pounds per foot, and the transition piece members are built-up beams 16 inches wide and tapering from 18¾ inches high at the bottom to 16½ inches at the top, with web plates 1¾ inches

thick, and flanges 3 inches thick. Because twenty-eight welds, all alike, were to be made, permanent patterns for forming the molds could be used advantageously in place of the customary wax pattern. Also, the work could be set up readily on a production basis. Beams were fabricated in pairs, while aligning and applying the molds to the second beam of each pair proceeded while the first beam was being preheated. Actual welding time was one-half day per weld, much less than would have been consumed in fabricating these beams by any other process. In addition, the fact that sound welds of ample strength could be obtained with welding without stress-relieving was important as no facilities for the heating of units of the size of the completed beams were available.

This vast freight car is used for transporting large ingot molds between two of the steel company's mills. The builders point out, however, that it is able to travel, without exceeding clearance limits, any place where rails and bridges are heavy enough to support the load. Cars of this type, therefore, open possibilities of transporting very heavy machinery and equipment completely assembled instead of having to take apart such units for shipment and then having to re-assemble them at their destinations.

Thermit welding may also be used advantageously to unite heavy and dissimilar steel sections and the fabrication of charging peels is an excellent demonstration of this process. The peels, which charge the raw materials into the open-hearth furnaces, are subject to alternate periods of extreme heating and cooling, causing the charging ends to develop fire cracks. Because of the widely different temperature and different wear requirements at the different ends, some steel plants have their peels built in two parts, the part that charges the furnace is made of a heat and wear-resistant alloy steel, and the other part is made of mild steel. Welds join the dissimilar sections to form the complete charging peel which is about 15 feet long and a foot in diameter. Figure 9 illustrates the assembly of such a peel.

Another unique and striking example of the adaptability of the welding process was the construction by the Electric Steel Foundry Company of Portland, Oregon, of one of the largest bending rolls of all time. These rolls consist of a large cast top roll and two somewhat smaller, forged lower rolls. The plate to be bent is fed in between the top and the two bottom rolls, the height to which the upper roll is adjusted determining the radius to which the plate is curved. The large top roll was 31½ inches in diameter and the face of the roll was 38 feet long. As the casting from which this is made would weigh some 50 tons, and would have to be cast on end, there are only a few foundries in the United States which could produce such a piece and these were overtaxed at the time with other work. It was decided to make the roll in two sections, welding it together in the center. The castings for each half weighed approximately 25 tons in the rough. These hollow halves, having a rough core diameter of 19 inches, were carefully rough turned in a larger lathe. After the turning process, temporary plates were tack welded in the hollow centers about two feet from the ends to be joined. The cores were then rammed up solid with molding sand, and grooves cut around the entire inside circumferences, leaving the finished core sand about 17 inches in diameter. The groove, extending lengthwise of the roll about four inches in each piece, and ending in a large radius fillet, was then filled with wax and the two edges of the roll were brought into alignment.

The next operation consisted of filling the gap between the halves with additional wax, after ramming a sand core between the two halves. This core united the two sand cores previously made in the ends of the roll. A band of wax about eight inches in width and one inch thick, carefully made, and smoothed with hot slicks, was then applied over the joint on the outside of the roll. A mold box was built around the roll ends and the space between the rolls and the box was carefully rammed with molding material. On each side of the box, heating gates were formed, six in number, to allow preheating by kerosene pressure torches. After the wax melted, leaving the cavity to be filled by the

Figure 8 — One of the supporting beams of the chassis of a 500,000 pound capacity freight car is shown being prepared for assembly by welding. Molds are on beam.

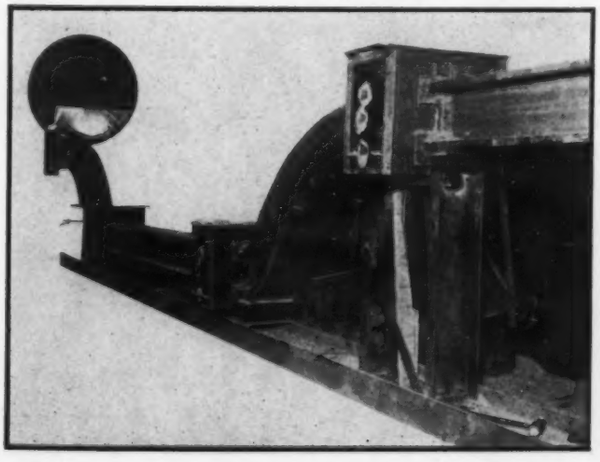


Figure 9 — This charging peel has an alloy charging end welded to a cast mild steel body. Weld is being made at time photograph was taken.

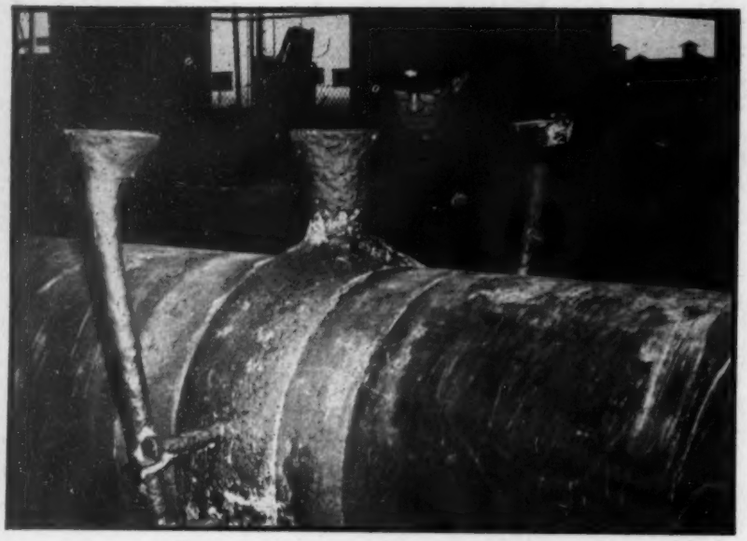


Figure 10 — Facilities were not available to cast the bending roll shown, so the roll was made by welding two sections.

molten steel, the shaft ends were preheated for fourteen hours to a bright red. After two crucibles were swung in place above the vertical pouring gates, the thermit was ignited and the 1450 pounds of the mixture turned almost instantly into white hot steel which was tapped into the mold. This was the final step in a process which required a week's time and the labor of three men. An additional thirty-six hours was allowed between the pouring and the stripping of the mold. An inspection of the weld indicated that when the roll was finished, machined and polished, there would be no discernable junction of the parts. The welded roll is shown in Figure 10.

In repair work, welding is indispensable; mill operators have reported good results on most common and vital repair jobs, the renewing of worn wabblers, the replacing of teeth on pinions, and the welding of roll necks.

The reclaiming of the worn pods of wabbler ends of both rolls and pinions is still another important use of welding in steel plant practice. Where wabblers are badly worn away or battered, the worn section is cut away and a new neck is welded on. If the wear is not too great, however, the impaired parts may be successfully rebuilt. Wabbler thermit, especially designed for this purpose is employed and the resulting deposited metal, while machinable, is sufficiently hard and tough to provide longer wear than the original metal in the piece. In building up a worn wabbler, it is necessary, first, to provide a wax pattern representing the metal to be replaced. Either one of two methods may be employed in making this pattern. One method consists of first making a wooden pattern which exactly fills the space between the pods in a new wabbler. These wooden pieces may be dimensioned either from new rolls or from patterns from which the rolls are cast. With them in place between the pods of the worn wabbler, the wabbler end is surrounded with a piece of sheet iron, and molten wax is poured into the spaces, representing the metal worn away in service between the wooden patterns and the worn wabbler ends. The wooden patterns are then removed, a sand mold is rammed, the parts are preheated and the molten metal poured in the usual way.

Now, as to the replacement of teeth or parts of teeth on large pinions, another familiar steel plant repair job, we have a different problem than the ordinary weld, in that the tooth is a comparatively small projection on an extremely heavy steel casting. For this reason, if the repair were attempted in the usual way, the heat would be carried away from the point at which the weld was being made so quickly, particularly during the interval of removing the preheater burner and tapping the crucible, that, in many cases, no weld would result. Everything possible, therefore, must be done to conserve the heat at the weld, and it is usually necessary to heat the entire pinion to a red heat. This is done by bricking in the heavy parts and preheating with oil, or gas burners, operated in conjunction with the regular preheater, while the preheating for the weld is under way.

In this elaborate preheating process, however, care must be taken to bring up the heat slowly, as otherwise there is some danger of cracking the pinion. Further-

Figure 11 — The pinion shown has had two broken teeth, marked by crosses, replaced by thermit welding.

more, in all welds in which a small quantity of thermit steel is added to a heavy casting, special precautions must be taken to secure thorough fusion of the weld metal with the heavy part, especially at the edges of the junction line where the greatest strains occur. Even the slightest imperfection at this point will cause a tear to start and result in fracture of the weld. A perfect weld on this extreme fiber is difficult to accomplish because of a slight difference in shrinkage between the molten steel and the white hot steel of the pinion after a weld is poured. Full fusion for a considerable depth, even at the extreme edges of the thermit steel is, therefore, essential and for this reason it is desirable to have as large a surface as possible exposed to the thermit steel. This is accomplished by placing the pinion in a planer and machining out a slot in the main body of the pinion along the center line of the area where the tooth has been broken out. This slot is made half the width of the tooth and approximately the same depth, that is, if the tooth to be welded is six inches wide at its root, the slot is machined three inches wide and three inches deep. Another purpose of this slot is to produce edges or corners which melt readily and aid in the fusion. Patterns are constructed and fitted, and a pair of sand cores, mounted on boards, is made by placing the boards in the spaces between pairs of adjacent teeth and ramming these spaces full with molding material. Lag screws in the board permit easy handling of the cores.

The pinion is up-ended and mounted in an excavation on a solid foundation and the cores are placed in position on either side of the machined gap. The space between the cores is filled with molten wax to provide the pattern for the new tooth. After the wax has hardened, the cores are removed and the mold box is fastened securely to the pinion by metal straps bolted to the mold box and insulated from the pinion by three inches of sand and fire clay rammed in solid between pinion and straps. The mold is rammed with the usual gates, risers and vents, care being taken that the heating gate, the inner end of which connects the pouring gate to the weld, is the lowest point of the weld. When this operation is completed, a brick furnace is constructed around the exposed part of the pinion, clearing the tooth by about two inches, and a sheet iron casing is placed around the exposed neck. This casing is six inches larger in diameter than the neck and about four inches higher. It is rammed full of sand to provide insulation for the neck. The next step is preheating. A burner is placed at the bottom of the brick furnace and preheating is begun with a very mild heat to avoid too rapid expansion of the pinion. After the pinion has been thoroughly warmed, however, the burner is opened up and heating is continued until the entire pinion reaches a good red heat, or approximately 1200 F temperature. Pouring of the weld is done in the usual way with the crucible mounted while the heating is in progress. Figure 11 shows a pinion repaired in this manner.

The two special processes which I have just explained may indicate that thermit welding is complicated and costly, though the antithesis is actually the case, for the universal acceptance of this type of welding is due primarily to three standout attractions, namely, the low cost of such repairs, in contrast with the cost of new parts for replacement; the speed with which repairs can be made, as compared with the length of time required to purchase and install new parts, and the dependability of thermit welds and the fact that repairs so made are permanent. The cost of making a thermit repair usually ranges between 20 per cent and 50 per cent of the cost of making and installing a new part. The materials and equipment employed are invariably much less expensive than a new casting or forging, and the larger and more intricate the broken part, the greater this difference becomes. Labor costs, also, are generally lower and still further savings may be effected where regular welding departments can be established, and thus more speed and economy is obtained through greater efficiency. The principal permanent equipment required to set up such a department consists of one or two crucibles, a shop preheater and, possibly, a pneumatic rammer. The cost of all these accessories is less than $300. Materials needed are consumed in producing the weld. Other advantages of the process for repair work include the fact that no machining is required unless the weld collar interferes with operation of the part, and stress relieving is not necessary.

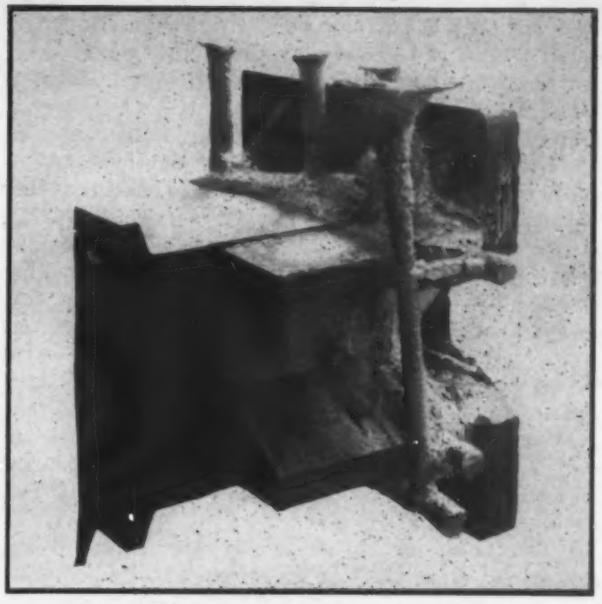


Figure 12 — A new end was welded to the manipulator rack as shown in two days.

An excellent case history of the advisability of maintaining separate thermit welding departments in steel plants came to my attention recently. A manipulator rack in a large mill had broken down and no spare was available. Operation of the mill without the rack reduced production about 30 per cent, and two weeks would have been required to obtain a new one. The broken part, however, thanks to welding as shown in Figure 12, was permanently repaired and reinstalled within two days, and the thermit welding section of this particular steel plant was credited with 30 per cent production for a period of ten days. Another mill reported that during a two-week period its thermit

welding department reclaimed, among other parts, three hot strip rolls, eight hot strip spindles, and five seamless tube rolls. To replace these parts would have cost $15,000, whereas renewing them by welding cost but $2,214.00.

The introduction of thermit welding departments in steel plants was responsible for the development of another application of thermit welding, namely, the replacement of metal worn away in service. This has proved a very profitable undertaking for many mills. Rolls, pinions, spindles, and many other parts, must be designed for toughness and strength, precluding the employment of steels having good wear resistance. It is perfectly feasible, however, in replacing the worn pods of these parts to employ a weld metal which will produce a steel of any desired hardness. In fact, the practice has been to select a thermit steel which is so hard as to be unmachinable, in which case the weld can be made true enough to eliminate all necessity for machining.

New applications and changes of this kind are being brought into use daily. It is entirely practical for the steel plant to make wabbler ends of a steel offering the greatest possible wear resistance and to weld such ends to the necks of ordinary rolls. In the same way, new charging peel ends are kept on hand which can be welded as required in place of broken or worn ends. Steels of extreme hardness may be cast on worn pods of wabblers on pinions, rolls, or crab couplings. Almost any part, by means of welding, may be designed to have different physical properties at various points.

All of these factors contribute to the making of parts with greatly prolonged operating life and the elimination, to a remarkable extent, of expensive replacements, shut-downs and repairs.

DISCUSSION

PRESENTED BY

GEORGE C. PFEFFER, Superintendent of Power, Florence Pipe Foundry and Machine Company, Florence, New Jersey

F. C. SCHOEN, Plant Engineer, The Midvale Company, Nicetown, Philadelphia, Pennsylvania

M. D. STONE, Manager Development Department, United Engineering and Foundry Company, Pittsburgh, Pennsylvania

J. H. DEPPELER, Chief Engineer, Metal and Thermit Corporation, New York, New York

Member: Was the housing you welded cast iron or steel and what were the economies of welding it?

J. H. Deppeler: That housing was cut from 8 in. thick plate and was thermit welded and electric welded to make the new housing.

Member: Is that housing stronger than a cast steel, or cheaper?

J. H. Deppeler: Considerably stronger than cast steel and much stronger than any cast iron housing.

George C. Pfeffer: Do you allow a flowing gate of any definite size on a large casting where you have a small section of weld? Do you allow a flowing gate to compensate for drop in temperature of the molten metal? If so, how do you arrive at the size of the flowing gate?

What temperature preheat do you use? Do you have any specified temperature that you arrive at for preheating?

Can Thermit be used for the welding of cast iron?

F. C. Schoen: In the welding of dissimilar metals, is it necessary to take any special precautions because of the difference in the cooling rates of a high alloy against a mild steel? You also said with the thermit welding, there are no locked-in stresses with a properly made thermit weld. That properly made thermit weld could conceal many headaches for some of us. Is it necessary that you have special trained personnel to handle thermit welding, or can we take the ordinary shop welder and make a thermit welder out of him, by reading a little bit of literature?

Another question in my mind was the one that Mr. Pfeffer brought up about cast iron. I believe you did say that on the large bending rolls, the top roll was cast iron which you welded together.

You described building, assembling, and fabricating frames for replacing cast frames. Is that because we can't make a proper repair on some of our cast-iron frames or is it just to get additional strength?

M. D. Stone: In the case of the pinion housing that was thermit welded, is the original cast-iron housing of welded or welded plate construction? Why couldn't a cast steel pinion be a suitable replacement?

I think the thermit welding process has established itself pretty well as an adequate repair process and sometimes we have considered it in new parts, which are too large to cast properly by casting the part in two halves which are welded together. So the welding has its place in new work, as well as in the repair field.

As a matter of interest, I would like to tell of an incident that happened a few years ago in which a large roll housing cracked during operation. The operators noticed the crack because of off-gauge material. They found the housing cracked practically through near the foot below the floor. The first thing everyone thought of doing was to take out the stand and thermit weld it. That seemed to be too long a process, so these people took their courage in their hands and decided to arc-weld the housing in place. The crack was chipped out so there was an appreciable "V" groove to permit electrode approach. I don't know how long it took to do the chipping. Once they started welding, and peening, they kept that up for 20 hours until completion. There was no preheating on this job because one could not work comfortably in the vicinity of a heated casting. The distortion was about zero. After completion of the welding, they started up the mill and it ran so well, that when the new complete housing was ready some four months later, they decided to leave the repaired one in, and the last I had heard the mill has

(Please turn to page 67)

Protecting Mill Equipment

WITH HARD FACING

. . . . hard facing of machine parts has been found a key tool for the maintenance man, which can many times increase the life of the machine part . . . .

by G. E. Wilson

SERVICE ENGINEER

HAYNES STELLITE COMPANY

KOKOMO, INDIANA

▲ A new hard-facing alloy has been proved by recent tests under operating conditions to have many advantages for use with various types of steel mill equipment requiring resistance to abrasion, heat, or corrosion. Typical applications where hard-facing has increased the life ten or more times include blooming mill hot shear blades, entry guides, twist guide rolls, angular type guides, and dies and shafts. This paper will discuss this new hard-facing alloy and indicate how it can be used most effectively for reducing steel mill maintenance costs.

One of the most serious problems in using the hard-facing metals available until now is a tendency for the deposit to check and chip when subjected to unequal expansion, impact, or shock. Experience has now shown the use of a nickel-base hard-facing alloy supplied under the trade-name "Hastelloy CHF" economically solves this problem. This rod can be applied easily by either the electric or oxyacetylene welding processes. It produces a smooth and uniform deposit of about 210 Brinell hardness, a deposit that is free from porosity and checks. The deposit is easily machined and does not require grinding. Furthermore, this alloy does not soften at elevated temperatures and it maintains resistance to checking and chipping at these temperatures. Surface hardness increases to as much as 400 Brinell through cold working. Even the pressure of such materials as crude rubber or ceramics working against the alloy rod deposit will increase the hardness of the deposit 50 to 100 per cent.

BLOOMING MILL HOT SHEAR BLADES

When this rod is used as a protective coating on blooming mill hot shear blades, it is deposited, usually by the electric arc, to a thickness of about $\frac{1}{16}$ to $\frac{3}{32}$ inch. Preheating the blades to approximately 400 F before applying the rod is recommended. However, hard-facing at room temperatures has been done with no apparent difficulties.

Even after the shear blade has been used considerably, the deposit does not chip or spall. There may be slight heat checks, but these are harmless as they do not penetrate to the base metal. Wear takes place very slowly, and the blade will operate at maximum efficiency until the cutting edge is rounded off. Since no cracking or chipping takes place, only ordinary cleaning of the worn deposit is required to prepare the blade for refacing. Blades used in the shearing of squares in sizes ranging from 4 in. by 4 in. to 12 in. by 12 in., and of flats in sizes from 2 in. by 24 in. to 8 in. by 48 in. last ten times as long as plain carbon or low-alloy blades.

Hot shear blades in one blooming mill which were originally made of 0.70 carbon steel were used for initial tests in facing with the nickel base alloy rod. The results were excellent. Blades of 0.35 carbon steel were then tested with the same results. Prior to hard-facing, one edge of a 0.70-carbon steel shear blade would last only six eight-hour turns before it was necessary to use another edge. With a high-alloy cast rod, the blades lasted for six weeks, or from 110 to 120 eight-hour turns. The edge faced with the high-alloy cast rod was not worn down but was badly chipped and required extensive rebuilding. With each rebuilding, the thickness of the deposit increased at the rewelded sections, and thus caused even more serious chipping.

The nickel base hard-facing alloy rod was then tested for rebuilding these badly chipped blades. This resulted in improved service because the rod eliminated serious checks without causing undue porosity. In addition, a certain amount of additional toughness appeared to be present.

One 0.70-carbon steel blade was built up with cast alloy and the second with the nickel base alloy rod.

Presented before AISE Pittsburgh District Section Meeting, April 22, 1946.

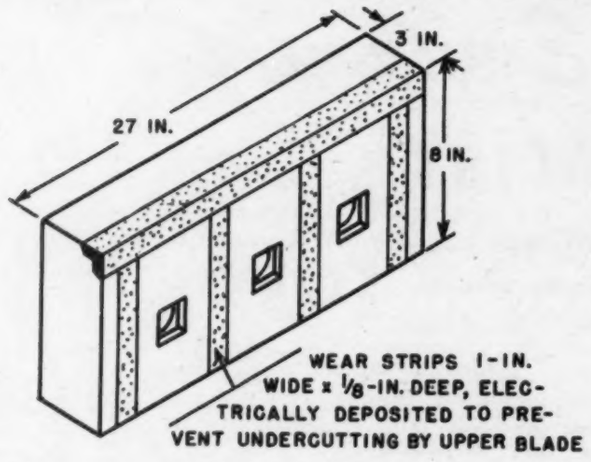


Figure 1 — The hard-faced hot shear blade has wear strips as well as a hard-faced edge.

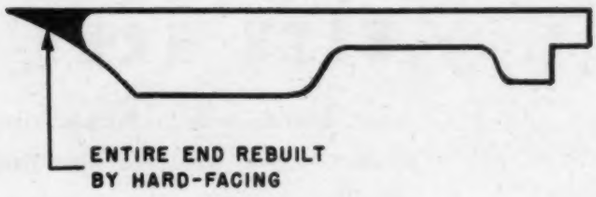


Figure 3 — This steel mill delivery guide lasts much longer than ordinary guides.

Both blades were installed at the same time. After 110 turns, the first blade was badly checked and chipped. The blade faced with the nickel base rod, though finely checked, showed no signs of chipping, and the cutting edge was merely rounded over. This blade would have been good for 10 to 20 more turns, but was removed so another test pair could be installed. Because of industrial conditions, additional tonnage was not run through these test blades, but it is estimated that more than 65,000 tons of 8 in. by 8 in. blooms could have been sheared. The cost of this kind of work will vary in different mills because some mills have the proper carbon steel available from their own porduction line while other mills purchase on the open market.

In one mill the nickel base alloy rod was used to face a pair of hot shear blades. The top knife was heat-treated and broke in two after only four hours of operation. The facing on this blade showed no signs of chipping or wear, and the failure was due entirely to the base metal. The knife used on the bottom position was 0.50 carbon steel and sheared 59,000 tons of steel, ranging from 5 in. to 10 in. squares. Average production for this type of blade is only 15,000 tons.

ENTRY AND DELIVERY GUIDES

When the nickel base alloy rod is applied to entry and delivery guides, the surface of the deposit is non-porous and so does not pick up scale from the bar or plate that would cause marking of the product. The minor heat checks which may appear do not have sharp edges to mark the steel since the deposit is soft enough to round off immediately. Guides hard-faced with this material last eight times as long as plain

Figure 2 — This detail of the hard-faced hot shear blade cutting edge shows a deposit 1 in. long on each side.

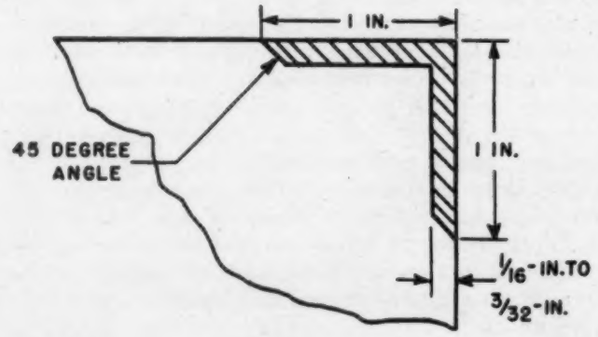
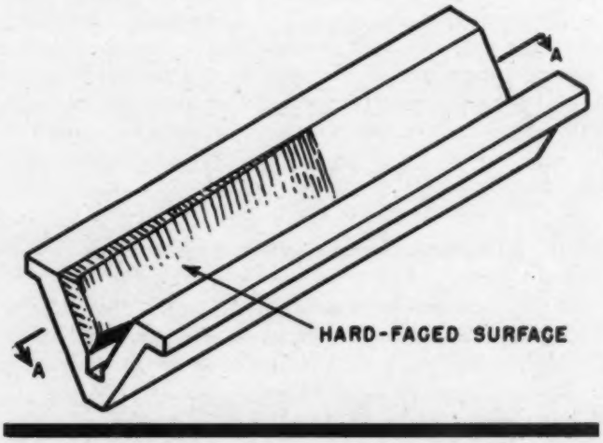


Figure 4 — Hard-facing this entry twist guide greatly increased its life.



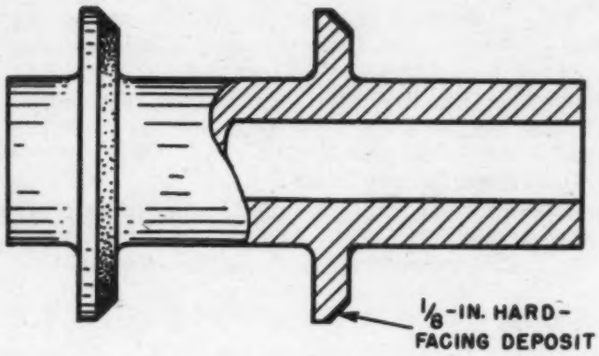


Figure 5 — Hard-facing can also be applied advantageously to this grooved horizontal twist roll guide.

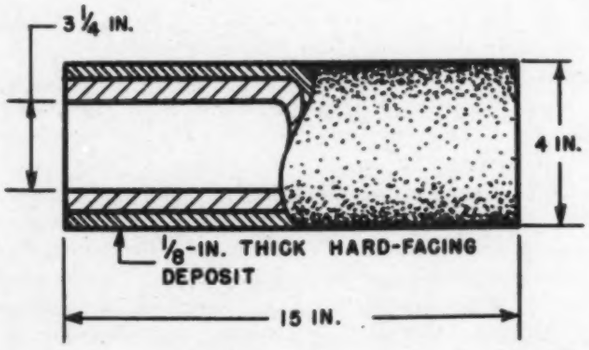
carbon and low-alloy steel guides and four times as long as high-alloy steel guides.

For example, on a 24 in. mill in Pennsylvania, entry guides faced with nickel base alloy rod rolled 15,000 tons of steel per week on 19 eight-hour turns. This was five times more than the tonnage rolled with steel guides not hard-faced. The initial cost of applying this rod was found to be approximately three and one-half times the cost of a new guide. The cost of rebuilding worn guides, which previously had been faced with the nickel base rod, was only twice the cost of a new guide, because grinding was not necessary and considerably less material was required.

HORIZONTAL-TWIST GUIDE ROLLS

Grooved horizontal-twist guide rolls faced with nickel base alloy rod on the contact surfaces have lasted six times longer than ordinary steel rolls. When these parts

Figure 6 — Hard-faced pump shaft sleeve.



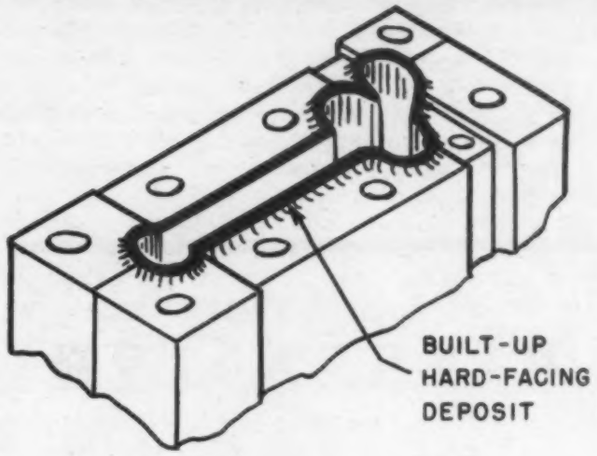


Figure 7 — Hard-faced hot trim die.

were resurfaced for the second time with this rod, they required a deposit of only one half as much material as was used originally, and no preliminary machining was needed.

When roller-twist guides 18 inches in diameter, used for rolling 2 in. squares, were hard-faced with the rod, their average life was four times the life of plain carbon steel castings or forgings. The original cost of rebuilding these worn guides with the rod was three times the cost of new rollers. When the guides were rebuilt again with the rod, however, the reclamation cost was reduced to approximately two to one, and they lasted four times as long as before.

Large angular-type guides used in the rolling of angles, channel and Z-bars produced 5,079 blooms when faced with the nickel base alloy rod. The guides that were hard-faced were a very high nickel-chrome alloy and were quite expensive so that the protection was particularly important in this case.

DIES AND SHAFTS

The nickel base alloy was tested in forging departments for hard-facing hot trimming and punching dies and for rebuilding worn and chipped cavity forging dies. It was successfully used not only as a reclamation metal but also as a protection of new parts before they were put in service.

Excellent results have been achieved by applying the rod to rebuild worn shafts and packing gland sleeves. This work is easily accomplished by arc welding followed by machining. The possibility of warpage and expensive grinding is thus eliminated.

Machinery parts exposed to sulphuric, hydrochloric, and acetic acids also have longer life when the surfaces are faced with the rod.

A summary of the alloy's characteristics is as follows:

1. The alloy is austenitic, with a Brinell hardness of 210.
2. It work-hardens to approximately 400 Brinell.
3. It has a low coefficient of friction.
4. The deposit is non-scaling with a high resistance to heat.

5. It has high tensile strength and ductility with excellent resistance to chipping and checking.
6. Edges of heat checks in deposits of the alloy immediately round off, lessening the chance for pick-up or scratching.
7. Welding fumes are not noxious, slag is easily removed, and a machinable non-porous surface is obtained. The deposited metal does not check during or after welding.

DISCUSSION

PRESENTED BY

P. F. RICHARDS, Superintendent of Maintenance, Carnegie-Illinois Steel Corporation, Vandergrift, Pennsylvania

J. J. BOOTH, Superintendent Maintenance, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania

G. E. WILSON, Service Engineer, Haynes Stellite Company, Kokomo, Indiana

C. J. DEGENHARDT, General Maintenance Foreman, Carnegie-Illinois Steel Corporation, Munhall, Pennsylvania

O. H. MEINEKE, Assistant Master Mechanic, Spang Chalfant Company, Ambridge, Pennsylvania

W. A. ANDERSON, Superintendent of Shops, Carnegie-Illinois Steel Corporation, Youngstown, Ohio

HERBERT CARTER, General Foreman, Boiler Shop and Welding, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania

L. S. TRACHSEL, Superintendent of Maintenance, National Tube Company, McKeesport, Pennsylvania

C. O. Franklin, Electrical Engineer, Carnegie-Illinois Steel Corporation, Munhall, Pennsylvania.

R. S. HURTT, Assistant Superintendent — Electrical, Crucible Steel Company, Midland, Pennsylvania

P. F. Richards: I want to know if the author could weld cast iron. We do not weld cast iron very successfully.

J. J. Booth: No, it cannot be done sometimes.

P. F. Richards: I was interested in knowing if the gentleman can weld cold shear blades?

G. E. Wilson: No, at the present time, I don't think we want to work on cold shear blades. We are going to be sure we are on the right path, before we try to weld the cold blades.

P. F. Richards: Do you think they would hold up in tin mill blades? That is a cold but a light shear job.

G. E. Wilson: To be very truthful, figuring the properties of the alloy, I do not think it will stand up. I hope I am surprised on that statement someday.

C. J. Degenhardt: I would like to ask about scrap shear chutes. We are using inherently hard steel plate liners now for cold material, and I would like to know if you have welded hard steel liners.

G. E. Wilson: I have considerable experience with that application, but I really believe that application is better handled by the inherently hard hard-facing materials. That is a case where it does not matter whether you have checks or porosity, and what you want is the best material.

C. J. Degenhardt: That is right.

G. E. Wilson: Are you using an iron base or cobalt base material?

C. J. Degenhardt: At present we are using hard steel liners; but I wondered how the nickel base hard-facing alloy would compare in case the liner became worn badly at one place.

G. E. Wilson: I don't think it would be the material for that.

O. H. Meineke: I wondered if it can be used on upsetting dies?

G. E. Wilson: Yes, on dies for upsetting bolts and similar uses.

W. A. Anderson: Has this material been used on gears?

G. E. Wilson: No, it hasn't. I think it will be, but I think I can suggest some rods that are cheaper which will do just as well. We believe the real uses for this material are where you have high heat and high friction, plus either high pressure or impact. In building up gear teeth, it would do an excellent job, but there are other rods considerably cheaper that would be just about as good on that application.

Herbert Carter: We have tried that rod on four of our 40 in. blooming mill shears but have no report as yet. That is the only place we have tried it.

J. J. Booth: In other words, it is in process now?

Herbert Carter: Yes, on four blades.

L. S. Trachsel: I am wondering if there has been any work done on coating finishing passes on mill rolls?

G. E. Wilson: It has been tried on rolls, but exactly what type of rolls they are, I don't know. It is my understanding they were steel rolls and a deposit was built on about ⅛ in. thick. The report I received was that they apparently had lasted about four times longer than rolls usually last in that particular position. That is something that will develop as time goes on.

C. O. Franklin: I would like to ask if this material has ever been used for the digging edges of scoops for grab buckets in cinder yards? That is a hard job. They handle hot material, and are subjected to impact and practically all the other stresses you mentioned in your paper.

G. E. Wilson: I believe it will work all right, and can see no reason why it won't. That is all loose material, isn't it?

C. O. Franklin: Sometimes the material is loose, but after prolonged use of the drop ball, the bed becomes very compact. Then the grab bucket really has a digging job.

G. E. Wilson: The only thing is the possibility that the material will not work-harden quick enough to resist the wear you get, although I still believe it might possibly be a good application.

Member: Could you put your rod on a manganese lip?

G. E. Wilson: Yes. One thing we recommend about this material is to use as low amperage or low voltage as possible. Therefore, on manganese steel it would be an excellent rod.

R. S. Hurtt: We have been using a very hard surface material on our ore bridge buckets, and we generally back it up with stainless. We find it lasts longer with the backing formed by the first coat of stainless, with the hard rod on that, than when welding directly on the parent metal. Have you found that true where you have first put on a coating?

G. E. Wilson: I have been around in plants where they built up lips on all types of buckets and quite a few years ago they used stainless steel. I would say 99 per cent preferred to put on one bead of stainless steel and then put the hard facing on top of that. I have found in my travels that procedure has been abandoned in favor of putting new and better hard-faced materials directly on the manganese materials. They use a very hard material out toward the edge of the lip for about 1½ to 3 in., and then in back of that use a chrome-manganese austenitic rod. Then, one gets the even wear all the way back with the inherently hard material on the edge taking the brunt of the wear, and the two materials will wear down fairly evenly.

Thermit Welding in Steel Plant Maintenance

DISCUSSION

(*Continued from page 62*)

been running three years and the new housing is still waiting to be used.

J. H. Deppeler: Mr. Pfeffer asked if we allow a flowing gate to compensate for the drop in temperature of the molten thermit steel. What we do is to have a vertical gate through which the thermit steel is poured and then we put connecting gates every 12 or 18 inches of height. There will be a loss of heat, but this is compensated by having a second gate through which the second thermit steel goes in, and a third gate through which the thermit steel goes in, and so on. By that means we have welded boiler drums 20 ft long and 2 in. thick, by using connecting gates up through the height of the piece. By that means we can compensate for the loss of heat.

The temperature of preheat is approximately 1700 degrees F. That is the usual preheat used in rail or other welding; and then the thermit steel increases the temperature up to at least 2800 degrees or more, as the part is fused.

Thermit welding is applicable to welding cast iron. We have heavy cast iron pieces that can be just as well or better thermit welded than electric welded, because welding on cast iron by electric fusion is a dubious process. We have had castings, these great big headers for presses, 7 ft thick and 7 ft high and therefore 7 ft square, and we have made that weld without any difficulty. The only difficulty is due to the greater shrinkage of thermit steel than that of the cast iron parent metal. Otherwise the thermit steel can be made to suit the cast iron chemically. This is what we do in our cast iron thermit. We do avoid any great hardness from the 3 per cent carbon of the cast iron which naturally is picked up from the part being welded.

Mr. Schoen asked about high alloy steel welding. We have no difficulty in making the high alloy welds with the ordinary thermit steel because the weld is always a compromise between two parts. That is, you pick up the alloying elements from the inch or inch and a half you melt away from the alloy steel and therefore you have the alloy steel in the parent metal, with a gradual graduation of the alloy successively down to the mild steel in the middle. There is no difficulty in making that weld. There is no pronounced difference in shrinkage.

He also asked how we trained welders. We don't need a man who has any great training. In electric welding, we must have a man who has a certain manual dexterity. Any man can be broken in for thermit welding. We have taken all the ship yards of the country and broken them in on making our welds. Our procedure is to have our man go down and spend a week and a half or so, and the first part of the time he would make his own thermit welds. Then he would let the shipyard men make their own thermit welds, and a month later he might come back to see how they were getting along. So we had no difficulty in breaking in great numbers of thermit welders.

Mr. Schoen asked also about the welding of cast iron and the replacement by steel to get additional strength. We have had a great deal of cast iron roll repairing by putting on a new neck of steel, and we usually weld that steel to cast iron by means of thermit without any difficulty. In some of the unusual cast irons we have had some difficulty recently. Someone brought up a question about chilled cast iron, and the steel rolls, and the effect of welding on the chilled surface. You of course can't weld the chilled surface itself; if you do, you are going to take away the effect of the chill and have to reharden the surface, but you can weld the neck of the roll without any difficulty. There is no difficulty in welding chilled cast iron so far as we are concerned, except for a matter of six or 8 inches each side of the weld, where the chill is lost.

Dynamic Balancing

OF ROTATING MACHINES

. . . . with the ever increasing speed of machinery units, vibration becomes more and more a problem; and the accurate balancing of rotating parts becomes more and more essential . . . .

by A. G. Gebhard

MASTER MECHANIC

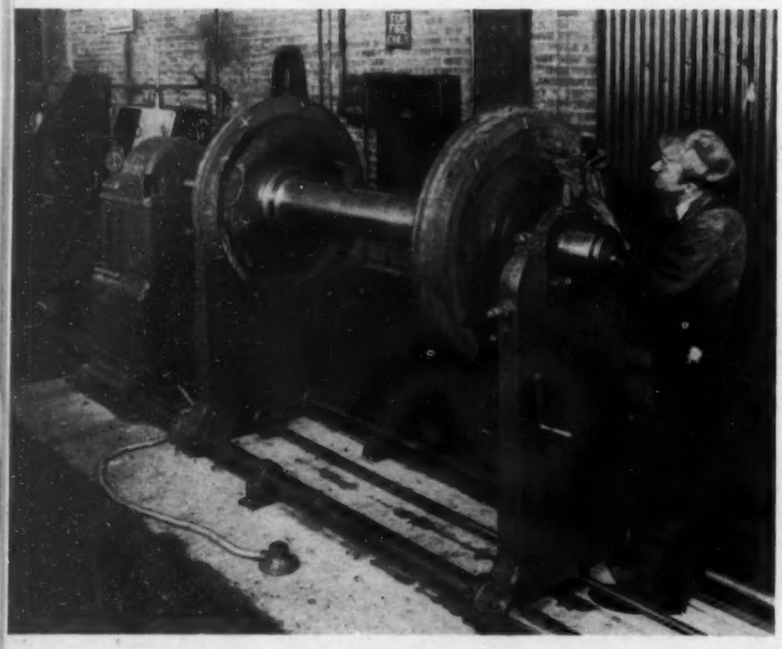
ILLINOIS CENTRAL RAILROAD

CHICAGO, ILLINOIS

▲ IN the steam locomotive field, there are not many parts on the locomotive that require dynamic balancing and most of it is static balancing. In the freight car department, if there was any unusual wear or any shifting it was more or less attributed to rough handling. With the passenger car, starting from the early days with the gaslight and then next with electric lighting, any unusual disturbance through vibrations was appeased by the use of snubbers or shock absorbers.

Presented before AISE Chicago District Section Meeting, January 8, 1946.

Machines for balancing rotating parts are finding ever increasing use in modern maintenance shops.



The next item was our suburban cars, having traction motors. We did have some bearing failures, but as long as we could keep the number in line with the previous year, we were fairly well satisfied. Then came the diesel locomotive, with its number of reciprocating parts, where tolerances are regulated in thousandths. We had little trouble while the equipment was new and when replacement parts became necessary, we did very well even then.

Then suddenly we had bearing failures. One was an armature bearing that froze, and the next was a roller bearing. In the railroad and iron and steel industries lightning cannot strike twice in the same place. We immediately started research to find the solution. We have what is called a breakage report. In all cases of failure, this report is inaugurated, the item concerned is tabulated showing the manufacturer, type of lubrication, periods of lubrication, and the report is kept active until the solution is found. In most cases, a solution is found within a short period of time, and in some cases, it requires over a year. However, the file is kept active until we definitely satisfy ourselves that we have found the trouble.

One of these breakage reports brought to light something of interest. We had a traction motor that was overhauled in our shops and sent to an outside plant to be used in case of emergency, and after a period of time the emergency presented itself, and the traction motor was used, failing on the first trip, necessitating withholding the locomotive for traction motor change Immediately we set this report to work and every indication pointed to neglect on the part of maintenance force. However, the maintenance personnel said it was impossible to overlook what had happened to the traction motor, namely that it was a fan that had broken. We checked with the other end of the road and they advised there wasn't a thing done to the traction motor by them. It seemed as though we were

going to have to censure the maintenance organization who had overhauled it. However, our file wasn't closed. We left it open, because the condition was such it was almost impossible for an irregularity of that type to happen in such a short period of time.

After investigating and still keeping the report active, we found that the mechanic at the other end of the road felt that our methods of adjusting the brush tension were wrong, and he attempted to fix it to suit himself. He had misplaced his small wrench which found its way to the pole piece, and the next thing off was the fan. After taking the report back, informing, "This is what we found and we would like for him to be honest," he admitted that is what happened. That is what our reports are able to do for us.

Getting back to the two failures that we had with the armature bearing and the journal bearing, we immediately set in to investigate and started research program to determine just what we were going to have to do. After much study, we found definitely that we would have to go into dynamic balancing, particularly on wheels. The balancing of armatures and fans is not much of a job, and one we can easily master, but the big problem is to balance wheels.

We sometimes find our wheels on the streamlined equipment out even though we take every precaution, and axles are turned throughout. Wheels termed "finished" are only semi-finished, mounted and then ground, after which we find them as much as four to eight pounds out of balance. Our question is how are we going to balance wheels?

In general we are limited in welding and drilling. We are governed by Interstate Commerce Commission's rules, and it is definite that we cannot put a torch on a wheel, since overheating breaks down the molecular structure. Drilling or tapping on the wheel will start a progressive fracture so the next thing is to add weight. We have been experimenting for the past year and a half with various methods as to what we can do and what we can use on the wheel. We have tried several methods and the last, and most successful, consists of bonding with babbitt.

The next thing to enter the picture was the balancing of freight car wheels. There is a growing need for this, especially since speeds of trains are now much faster. In the past, the speed of our trains was not as fast as today and even today all efforts are being made to increase speeds. We know definitely the answer is balancing. Our period of research has reached a point where the foundation has been set. Machinery is on hand and we are now waiting for the opportunity to go forward with an extensive balancing program. At the present time, we are balancing practically everything on passenger cars, such as motor generator sets, fans, clutches, pulley wheels, etc. We are expecting to reach deep into the field of balancing equipment.

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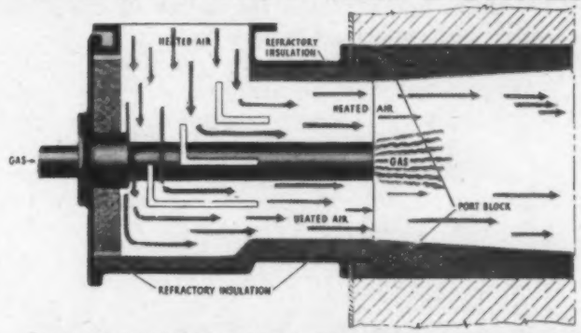

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Control of Vibration

. . . . many equipment failures are in reality fatigue failures which have been accentuated by vibration . . . . such failures may be reduced through the proper use of damping materials . . . .

by Alvin W. McKaig

DIVISION MANAGER

FABREEKA PRODUCTS COMPANY

PHILADELPHIA, PENNSYLVANIA

▲ CONTROLLING vibration is a subject so complex, extensive and important, that it is difficult to give the matter justice in a brief paper. However, the following paper will perhaps include more practice than theory but will touch upon the importance of high frequency vibration in the fatigue of metals with particular reference to heavy machine parts and structures. The illustrations are offered as an aid to understanding the practical problems mentioned from time to time and to indicate how easily and inexpensively, extensively troublesome vibrations have been successfully reduced in various fields without the use of advanced mathematics or complicated formula.

The control of vibration first calls for a definition or understanding of what is vibration. For all practical purposes we can consider mechanical vibration only.

In its simplest form, vibration can be demonstrated by a weight bobbing up and down when suspended by a small steel coil spring or rubber band. The rate at which the weight bobs might very well be once per second, that is, the time taken for the weight to move from one position down and back to the original position again, would be one second and the vibration frequency would be one cycle per second. It is sometimes hard to visualize this same type of motion when the frequency is greater and one complete cycle takes place in much less time, but it is this same motion at frequencies of 100 cycles per second or greater that is usually responsible for fatigue of metals and consequent damage and breakdown of mechanical parts in machinery or equipment.

The amplitude of vibration is the distance travelled by the weight from its top position to its middle position and the amplitude has, of course, also a very definite bearing upon the severity of the vibrations. The greater the amplitude and the greater the frequency, the more destructive are the forces of vibration.

The frequency with which the weight moves up and down when suspended by a spring or when mounted upon springs, rubber or other resilient materials is said to be the natural frequency of the weight or mass on its mountings. No external force or energy is supplied. On the same mountings, a mass of greater weight would have a lower natural frequency and a mass of lighter weight would have a higher natural frequency. The natural frequency can also be changed by altering the resiliency of the mountings, more resiliency giving a lower natural frequency and vice versa.

If, instead of mounting a weight on resilient mountings, a machine or motor was so mounted, another frequency or frequencies would be introduced, which is usually the operating speed of the machine, and this frequency can also be measured in cycles per second. This is known as the forcing frequency and is, of course, the vibration frequency or frequencies that are to be isolated.

With natural frequency and forcing frequency the same or nearly so, a condition of resonance will exist. This must be avoided to keep away from the increase in amplitude of the vibration which occurs when these two frequencies are the same or nearly so.

This relationship between a forcing frequency and a natural frequency is called a frequency ratio. For the successful reduction of transmitted vibration, the natural frequency of the machine on its resilient mounting should be less than one-half and preferably one-third of the rate of the forcing frequency. This fact is illustrated by the curves in Figure 1.

Most discussions on reduction of transmitted vibration treat vibration in the form of a wave motion and do not consider separately the effects of an impact shock. However, impact blows may occur only at infrequent intervals and yet in themselves may be damaging to mechanical equipment and foundations, although their frequencies are so irregular that they cannot be considered as wave motions. These impact shocks can also set up what is known as secondary vibrations which can best be understood by thinking of the vibration set up in a tuning fork when it is struck. The frequencies arising from such blows are

Presented before AISE Philadelphia District Section Meeting, March 2, 1946.

very high and range on up from 100 cycles per second to several thousand. This high frequency vibration often possesses a relatively large amplitude and can be as destructive and even more destructive than the original blow itself. There may be, and very usually are, a number of frequencies of secondary vibration set up in any mass by the impacts and any and all such high cycles will tend to induce metal fatigue.

Industry is giving great attention today to the destructive forces of high frequency vibration because it has proven to be the cause of metal fatigue which in turn results in the breakage of machinery, machine parts and transportation equipment and shortens the life of buildings, bridges and other structures. Such unbalanced forces cause loss of mechanical efficiency, objectionable noise or motion. Even people fatigue under high frequency vibration. This high frequency vibration must be damped or absorbed through unit design or properly engineered application of suitable materials, as shown in Figure 2.

Numerous books have been written on this subject and an excellent work is the "Prevention of the Failure of Metal under Repeated Stress" which is a hand book prepared for the Bureau of Aeronautics, U. S. Navy, by the Batelle Memorial Institute. In this authoritative treatise, it is made clear that metal fatigue is caused primarily by repeated stress which may be much less than the stress that would cause failure under static loading. Such failures usually begin at a surface notch, flaw or sharp change of section or contour. The following is taken from page 97 of this book. "In a structure subjected to repeated stress, failures sometimes occur which can be explained neither by the design stress nor by the local stress intensification due to a notch, but which are traceable to the natural 'tuning' of the structure, that is, to its potential natural period of vibration. If, by some force, the structure is set into vibration at this rate, the vibrations have large amplitude and high stresses occur."

Such external force may develop some impacts which in themselves may not weaken the metal but which do set up high frequency vibration which, in many cases, is destructive.

A further extraction from this book on page 211 is as follows: "The ability of a complete structure to damp out vibration of high intensity is very important. In the damping properties of a structure, the damping power of the metals in the component parts of course plays a role, though ordinarily a small one. A crankshaft or a machine base of high damping power will be of some help in damping out the high intensity harmonics, but in severe cases of high harmonics the matter has to be attended to by general design, or by the addition of special vibration dampers, to control the natural frequency of the structure."

Where is damaging vibration found?

In every branch of engineering, vibration problems occur. In industry you will find it in the power plant, in the shops, in the foundry, and throughout any part of a manufacturing layout that has machinery with moving parts. In the transportation field, one finds it in the various parts of the automobile, the bus, the truck, the airplane, the steam locomotive, the diesel locomotive, the streamlined passenger car, and the freight car. In the home, one finds annoying vibration

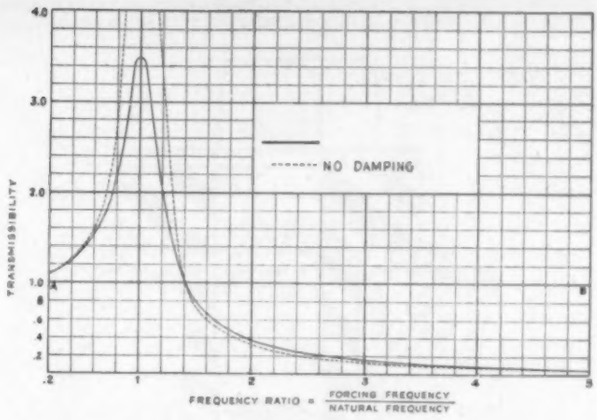


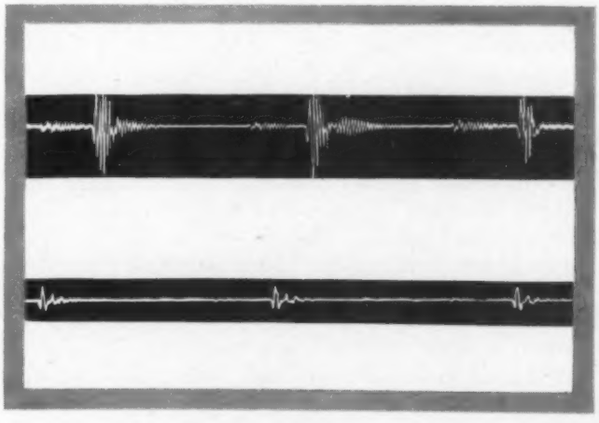
Figure 1 — Curve showing transmissibility of vibration at various ratios of forcing frequency to natural frequency.

problems in the heater or ventilating system, the refrigerator, or other house accessories that are operated by means of power. In the combat units for Army and Navy, one finds innumerable applications of mountings of different types for the reduction of vibration. There just is no end to a listing of vibration problems as they are known today.

This all leads us to what can be done economically and effectively to reduce vibration and what means are taken to do it.

The proper control of vibration is by no means a simple matter. Mountings may be engineered to have the proper resilience, but it may then be found that such mountings do not have the required stability or that they do not have sufficient strength to stand up under service conditions without prohibitive permanent set which robs the mountings of efficiency and life. The problem furthermore is often complicated by the presence of two or more different vibration frequencies, so that careful and intelligent analysis is necessary to determine which of the frequencies is most damaging. Also the nature of the sub-structure or base of a machine plays an important part. A base set on bed rock would be so solid that more resilience would be required for

Figure 2 — Upper graph shows the charted vibration of a mounting using no isolation, and the bottom graph shows the reduction in the vibration, when a 5/8 in. layer of special duck and rubber laminated material is used.



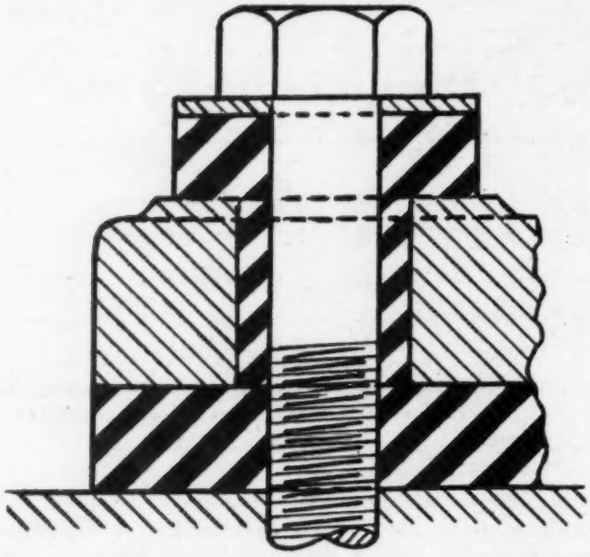


Figure 3 — The bushing and the pads shown on this sketch prevent passage of vibration from the machine to the floor.

isolation of vibration than if mountings were to be used where the inherent resilience of a structure could be taken advantage of, as on wood floors, the hulls of ships, transportation vehicles or airplanes.

A number of methods for reducing transmitted vibration are now generally in use such as shear mountings, compression mountings, friction mountings and those that depend on the stressing of steel in torsion.

We need to go into some detail on the shear and compression type mountings but will not discuss the friction type units or torsion springs. However, these latter developments play their part well in the control of vibration. The constant steel to steel friction unit set into the spring groups of freight car trucks has been successful in the reduction of dangerous resonance and bouncing. The hydraulic type shock absorber is extensively used in transportation equipment to check progressive harmonic motions and sway. In the torsion bar spring, the twisting action of the steel bar supplies the springing effect. This is an interesting development in one of the new postwar automobiles.

Shear mountings are made in the form of a sandwich with rubber or synthetic rubber being bonded by vulcanization to steel plates on each side. A tubular construction is often used with inner and outer steel tubes replacing the two steel plates. Units of this type are loaded parallel to the vulcanized surfaces and the resulting shear action on the rubber is employed in order to obtain greater deflection of the rubber than could be obtained by the use of rubber in compression under similar loading. This is due to the fact that rubber is not compressible and depends on "flow" for its resilience. Shear mountings are commonly used for the lighter unit loads and where maximum resilience is required in order to isolate low frequency vibration.

Compression isolators are most commonly used and are familiar to everyone. They include the use of such materials as steel coil springs, cork, felt, rubber and laminated materials.

Coil springs can be designed for light or heavy loads, but they have the disadvantage that they provide little or no damping. It is therefore common practice to use shock absorbers in connection with such springs. Also it is often necessary to provide proper stability by the use of spring groups or supports, or both, to prevent horizontal motion. Steel coil springs are usually excellent for the isolation of low frequencies because they can be designed to provide a great deal of resilience, but due to their steel construction they will transmit high frequency vibration through the steel coil itself. This can best be illustrated by the coil springs used in railway passenger cars, which are designed for the isolation of low frequency vibration. It has been found necessary to use pads of a laminated material under and over these springs in order to prevent the transmission into the car body of the high frequencies caused by the rolling of the wheels on the rail and the impacts of the wheels on rail ends.

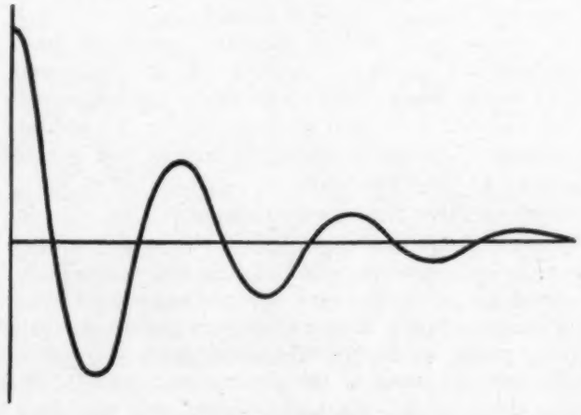
Elliptic and semi-elliptic springs depend on a combination of friction and the bending of spring steel. Their use is almost entirely limited to railway equipment and to the automotive industry, which includes automobiles, buses and trucks.

Rubber, cork and felt in compression are useful mainly in the field of lighter unit loads. Both cork and felt give reasonably high damping values. Laminated materials can be designed and manufactured to provide considerable damping and for use under very heavy unit loadings. An illustration of such an application is shown in Figure 3.

For the control of vibration the following physical properties are of importance for the requirements of a vibration mounting under various conditions.

Resilience — Some resilience is required in order to isolate any vibration. More resilience is required for light loads and low frequencies. When loading is heavy and vibration frequency is high, the resilience can be very limited, and where heavy machines are involved,

Figure 4 — Damping curve for special duck and rubber laminated material. Damping ratio is 1.6.



such limited resilience is required in order to insure stability.

Stability — In the design of a mounting consideration must be given to proper stability. The frequency and load may call for a mounting that would be impractical because too much motion would be permitted. This fact indicates that in many cases a compromise mounting must be used, particularly where there may be heavy pipe connections, such as in the case of a compressor or pump.

Strength — Where loadings are heavy, great strength is required in order to insure long life, particularly under severe service conditions. This is particularly true in the case of railway equipment and such heavy units as forging hammers, foundry shakeout machines and heavy engines.

Limited permanent set — This is important to insure continued efficiency. Permanent set indicates lost resilience, and after a certain interval of time, this would mean that the mountings were not doing the job for which they were designed and installed. In addition, permanent set may cause important changes in necessary clearance and required tolerance.

Damping — Damping is a force that resists motion and causes a vibration wave to die out. It is very valuable in reducing vibrations at or near resonance. Damping means the absorption of energy and in most isolating materials this absorption is accomplished by internal friction. It has already been brought out that no natural materials have more than a slight amount of damping, although laminated material can be made to specifications that afford considerable damping.

For example, such a laminated material is made from a particular type cotton duck impregnated with rubber and plied up to required thickness. It dampens vibrations 4 to 1 times better than rubber in compression and 100 to 1 times better than steel coil springs. A damping curve for such material is shown in Figure 4. A load-deflection curve is given in Figure 5 and a photograph of the material is shown in Figure 6.

Perhaps it might be of interest to list a few vibration problems that were corrected in heavy equipment on the railroads or in industry after careful observation of the units in service.

One is the difficulty encountered by the railroads in the breakage of semi-elliptic springs on locomotives. This has always been a problem to the railroad mechanical men and certain locomotives are bad actors in this respect. In one such case, the breakage of elliptic springs constituted a very severe problem until pads of a laminated material were installed beneath the spring end clips at each end of the elliptic springs. This application entirely eliminated the breakage of springs and it is important to note that this breakage was not even caused directly by impact shocks, but by the secondary high frequency vibration set up by the impacts, these impacts in turn being caused by the locomotive wheels on crossings, switches and rail ends.

Another similar case may be mentioned where a ⅝ in. thick laminated pad was placed on top of the journal boxes on the engine trucks of locomotives. This particular pad served to relieve the mechanical stress of a one piece side frame resting directly on the boxes

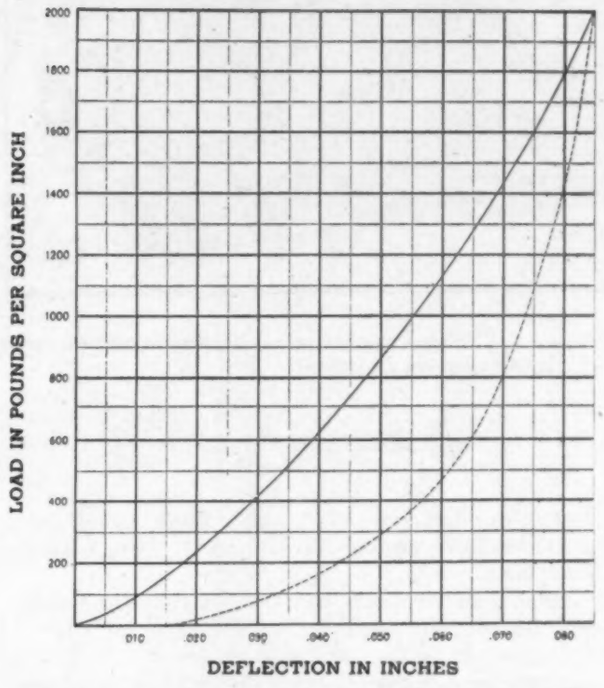


Figure 5 — Load deflection curve of 39 ply special duck and rubber laminated material. Solid line is loading curve and dotted line is unloading curve.

where it eliminated the breakage which had been caused by metal fatigue.

On locomotive tenders where coil springs were used, similar pads were installed on top of the springs themselves in order to stop spring breakage. It had been believed previously that these springs had been breaking because impacts were driving the springs solid but this was quite evidently not the case because the installation of pads brought an end to this spring breakage after many thousands of dollars had been spent without success to improve the qualities of the springs themselves.

Pads under the anvil of forging hammers have served to prevent the breakage of pistons and here again the cushioning of the impacts caused by the operation of the hammer resulted in a reduction of transmitted high frequency vibration throughout the frame of the hammer itself. That these vibrations can be transmitted a long distance was shown in one instance where the operation of forging hammers greatly damaged a church structure 2½ miles distant across a valley.

Foundry shakeout machines have been mounted on pads to cushion the impacts and reduce the transmission of very damaging vibration. Such an installation will reduce maintenance by cutting down on the number of broken parts and by prolonging the life of bearings. Figure 7 shows a shakeout machine, and Figure 8 shows details of the mountings for the machine.

Where accurate work is required of grinders, the installation of pads under the feet of the grinders has substantially improved the quality of the work done as well as cutting down on the number of rejections due to imperfections in the surface. In one large airplane engine manufacturing plant, one particular type of

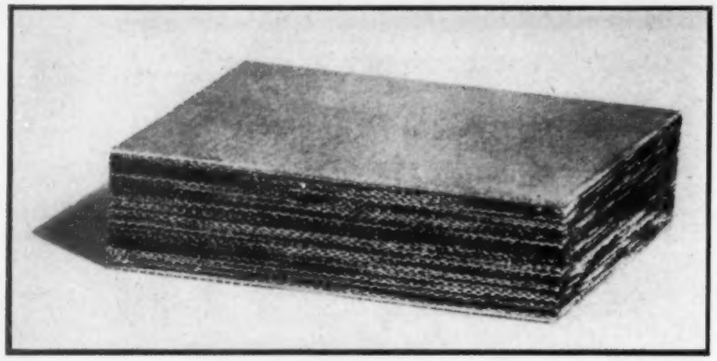


Figure 6 — Special duck and rubber laminated material used to reduce vibration.

boring machine created a reject finish on all parts produced by a grinder located 190 ft distant on the same floor.

Dynamometer stands, balancing machines and laboratory instruments must be isolated from the effect of vibration set up by adjacent machinery. In a large cigarette manufacturing plant the layout of machinery and conveying equipment on the ninth floor created a very severe vibration condition with the measuring instruments in the laboratory on the third floor.

The printing presses in the basement of a large Chicago newspaper created enough vibration disturbance in the radio broadcasting studios on the third floor of an adjacent building to compel isolation of the presses which was successfully done with an installation which included pads of a laminated material.

Disagreeable and fatiguing high frequencies in the seats and floor of electric powered commuter coaches on railroads have easily and inexpensively been eliminated by the application of pads on the spring plank seats of the trucks.

In many types of equipment used by the Army, Navy and Air Corps during the war, the nature of the equipment and the gruelling service conditions under which it operated required the use of material to absorb impact shocks and vibration. These installations were made for the purpose of prolonging the life of the equipment and insuring its better operation. A partial list of such applications would include the mounting of auxiliary equipment in submarines to prevent transmission of underwater noise, the diesel engines of landing craft to maintain constant alinement of propeller shafts, and to insure against breakage of engine mounting feet when boats were subjected to impacts, airplane engines to reduce transmitted vibration to prevent pilot fatigue and breaking of metal parts, auxiliary equipment in tanks, engines of heavy trucks and fixed machine guns on tripod mounts to cushion shock load on bearings.

And so one could go on with an endless list of interesting applications for the purpose of reducing impact shocks, transmitted vibration or noise, to the end that metal fatigue and consequent breakage of parts might be reduced and equipment function more efficiently.

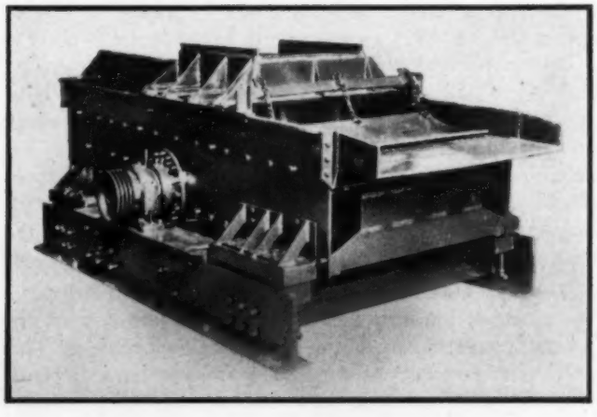
How are successful results obtained in the reduction of transmitted shock or vibration? The basic principles of a successful installation were briefly touched upon earlier in this paper and it was mentioned that the engineered natural frequency of the vibrating body on its mount should be from one-half to one-third as much as the forcing frequency. This natural frequency can easily be calculated and engineered by those engaged in the manufacture and sale of the various types of products offered for the absorption of vibration. The real difficulty lies in correctly determining the frequency of vibration which is causing the damage or trouble. Because a motor is operating at 1150 rpm or approximately 20 cycles per second, or a diesel engine is running at 1800 rpm or 30 cycles per second, does not mean that these two operating frequencies are those which may be causing the greatest amount of metal fatigue or the improper functioning of some nearby machine, or discomfort to people working in the neighborhood.

It is very frequently the case that the disturbing frequency that has to be damped out is set up by the operating frequency of the motor or engine and is several times as great. Tests made on the vibration frequencies set up by the operation of a diesel engine at 1200 rpm or only 20 cycles per second, showed the existence of frequencies of sufficient amplitude to give concern where they ranged as high as 6000 cycles per second.

An application of material to successfully correct such troublesome vibratory condition might frequently, therefore, be better designed to damp out the higher frequency rather than the lower operating frequency of the machine. Such an application being of less resilience would, therefore, afford greater stability, which, in turn, might be very desirable from the point of view of the successful operation and safety of the machine itself.

Again, in the case of impact machinery such as a forging hammer, the isolation of such a piece of equipment to absorb the force of the impact blow and prevent the transmission of an undue amount of vibration, cannot be made with too resilient a mounting, because the forging efficiency of the hammer would be reduced

Figure 7 — Foundry shakeout machine which must be mounted on pads to reduce vibration.



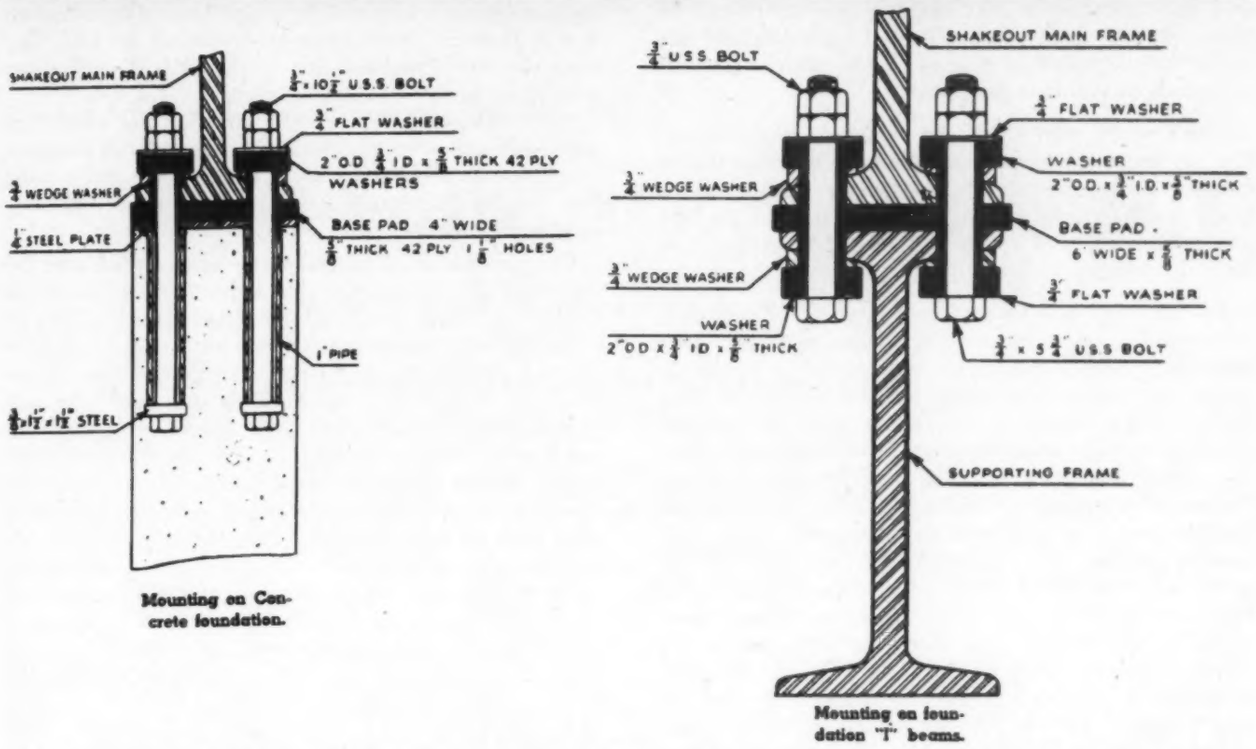


Figure 8 — On left is shown insulation mounting for shakeout machine of Figure 7 when mounted on a concrete foundation, and on the right is the same machine mounted on an I-beam.

and more blows would be required to perform the same operation.

An air compressor mounted on rubber in shear may vibrate dangerously but if the same mountings are reused and loaded in compression, one might have no trouble. Only the experienced hand knows why such things happen and what to do about it.

Therefore, in conclusion, it seems fitting and proper to point out that it is important to know the general theory of vibration absorption but it is still more important to have had or to secure the knowledge that comes only with experience. The use of instruments, of which there are numerous types to measure frequency and amplitude, will not of itself indicate the particular frequency range which impairs the life or efficiency of the machine. Practical applications which take into consideration all such factors as stability, strength, damping, operating characteristics of the machine and the critical frequencies to be isolated must be based more upon experience gained through practice than upon theory.

DISCUSSION

PRESENTED BY

CLYDE S. CASSELS, Engineer, Henry Disston & Sons, Inc., Tacony, Philadelphia, Pennsylvania

ELMER LATSHAW, Technical Engineer, ACF-Brill Motors Company, Philadelphia, Pennsylvania

A. W. McKAIG, Division Manager, Fabreeka Products Company, Philadelphia, Pennsylvania

Clyde S. Cassels: We have had some experience in using vibration damping material on motor-generator sets and under hammers. In the case of some comparatively light drop hammers, we have not noticed any great difference in the effect as far as the surrounding area is concerned, but the operators on the two hammers which are protected with damping material on top of their normal oak pads maintain that these hammers give us better die-life without any loss of power than we get from the hammers not so protected. This has been an appreciable help and we plan to continue to protect hammers in that way.

Some of our heavier steam hammers are protected in a similar manner. In the ones overhauled recently we installed vibration pads, not to cut down anvil loss so much as to cut down vibration in surrounding areas and local shock. This has proved satisfactory.

Elmer Latshaw: In the use of the firmer types of materials, engineers usually are at first a bit hesitant for they like to see a material into which they can sink their fingers, and which they can wiggle all out of shape.

In other words, it is partially true that good vibration isolation requires a certain amount of deflection, but problems do not resolve themselves simply by just caring for one particular frequency. For example, in a railroad car, the passengers may say that the ride is annoying. They have no way of knowing what frequency is causing the annoyance, and they may complain that it is a slow-speed bounce or pitch. You may improve that, but they continue to criticize the ride. Usually the fatiguing part of a vehicle ride lies in the high frequency range and high frequency vibrations can be

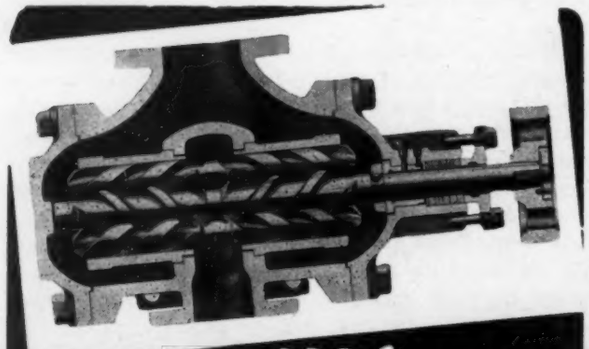
taken out by relatively rigid materials. I do know from first hand experience that much improvement can be obtained with some relatively rigid materials and one point that is gained by the use of the firmer materials is that the machine is more stable.

The trouble with all of the very soft mountings is that under some adverse conditions the machine moves excessively and the pipe connections or conduits break loose from fatigue due to some disturbance in the natural frequency of a very soft mount involving very large deflections.

In one very odd experience in vibration isolation, vibration experts who were specializing in very soft shear type rubber mountings were called in on an air compressor drive. The speed was known; or at least the speed was specified at a given electrical voltage. Everything was worked out very scientifically but when the drive was operated, the results were terrible. Passenger complaints were to the effect the car had terrible vibrations in spite of the fact that it was a very modern design. The engineers that worked out the mounting, could not find the reason. They checked the figures several times and everything should have been all right. However, by sheer luck the real cause of the severe vibration was found. The car was electric, propelled by overhead power, 500 or 600 volts, and out near the end of the line, the voltage fell off. At the lower voltage, this series of motor driven compressors fell to about half speed and right into the natural frequency of this very lively unit. Of course any spring run in its natural frequency is short-lived and transmits vibration worse than if there were no insulator at all. This example shows at least one of the pitfalls, and there are plenty in the vibration game.

A. W. McKaig: There are vibration problems that are some times very difficult because of the complex combination of systems involved, and the only thing you can do with them is to study them individually, on the job.

Our professors of mathematics are helpful, and by the way, Mr. Latshaw is one of the most able men in that field. These men have gone ahead in the field of vibration and figured a long time on the problem from the equation angle, and have been getting the theory down to a very fine point. Thus one can take any system problem and work on it quickly and easily to see how it may fit or combine into the final problem. Great thanks should be given to Mr. Timoshenko, for instance, and Den Hartog, Kemler, and others, as those men have all been working along these lines for many years and have produced a lot of valuable work on the subject. However, when you get into the books from the angle of industrial engineering, unless you have a lot of time, it seems hardly worthwhile to go all over the complete details, but rather preferable to take the fundamentals that they have offered us and use those as a basis for working out the problems. Actually, field experience seems to count a lot more in getting the answers.



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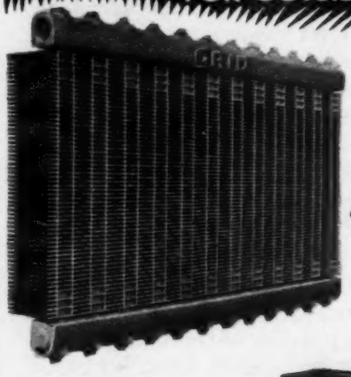

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Lighting Systems . . . .

THEIR MAINTENANCE AND IMPROVEMENT

. . . . the real lighting expert is the man with the soap and water . . . . and proper lamp maintenance is probably the most important single factor in good mill illumination . . . .

by Bernard F. Fantone

CARNEGIE-ILLINOIS STEEL CORPORATION

GARY, INDIANA

▲ UNFORTUNATELY, we do not have time to go into a thorough discussion of lighting systems, their maintenance and improvement. There are several well known manufacturers' publications which give excellent treatment to this subject, and they describe the following topics:

1. The relation between the cost of light and the frequency of cleaning.
2. Benefits of painting walls, ceilings, floors and machinery.
3. Cleaning solutions for different types of reflectors and globes.
4. Practical methods of reaching lighting equipment for cleaning and relamping.
5. Trouble-shooting charts for incandescent, mercury and fluorescent circuits.

Such literature may be obtained from the manufacturer free of charge.

Extensive surveys and researches have been made to determine the minimum amount of light required to perform specific visual tasks with a maximum of efficiency on the part of the workman. This information is prepared by the I.E.S. and approved by the American Standards Association and covers lighting in offices, schools and many industries. One of these publications, "The American Recommended Practice of Industrial Lighting," is available at twenty-five cents per copy. The minimum footcandle recommendations are based on actual maintained, or " in service" conditions, and not on the popular, but generally misleading, maintenance factor of 70 per cent which is erroneously applied on many lighting designs.

In systems using direct-type lighting equipment, the maintenance factor is determined principally by the depreciation in the lamp filament and by the permanent and temporary depreciation caused by accumulation of dirt on the reflecting or transmitting surfaces of the fixture. The point we would like to bring out is this: If a lighting system is designed for a minimum amount of light for a specific visual task, this minimum value must be maintained or quantity, quality and cost of production will be adversely affected.

Mr. Willard Brown, a past-president of the I.E.S., once stated, "The real lighting expert is the man with the soap and water." If he neglects the cleaning problem too long, it will eventually return to haunt him in the form of permanently deteriorated equipment, and particularly with complaints from the production department where production has suffered, and where the employee's visual comfort has been aggravated by headaches, four o'clock fatigue and other complaints which tend to undermine morale.

Regarding the subject of cleaning and relamping, we know that fixtures suffer dirt accumulation in amounts varying with the degree of contamination in the atmosphere. It is also understood that this accumulation varies exponentially with time; however, for short periods of one to two months, the depreciation at the end of two months is approximately double that at the end of one month. Lighting authorities have developed a simple mathematical formula which shows that this wasted light can be salvaged economically. Take for example an atmosphere where the dirt depreciation is only four per cent per month; in this case you will get more light for your dollar if the units are cleaned every six to twelve weeks. The length of time between cleanings depends on maintenance costs, waiting for cranes and similar delays. On the other hand, if the dirt depreciation is 20 per cent per month, light can be produced most economically if the fixtures are cleaned every four to six weeks. Of course, there are fixtures that will have more permanent and temporary dirt depreciation than others. The best selection depends on the combined experience and judgment of both the maintenance man and the design engineer.

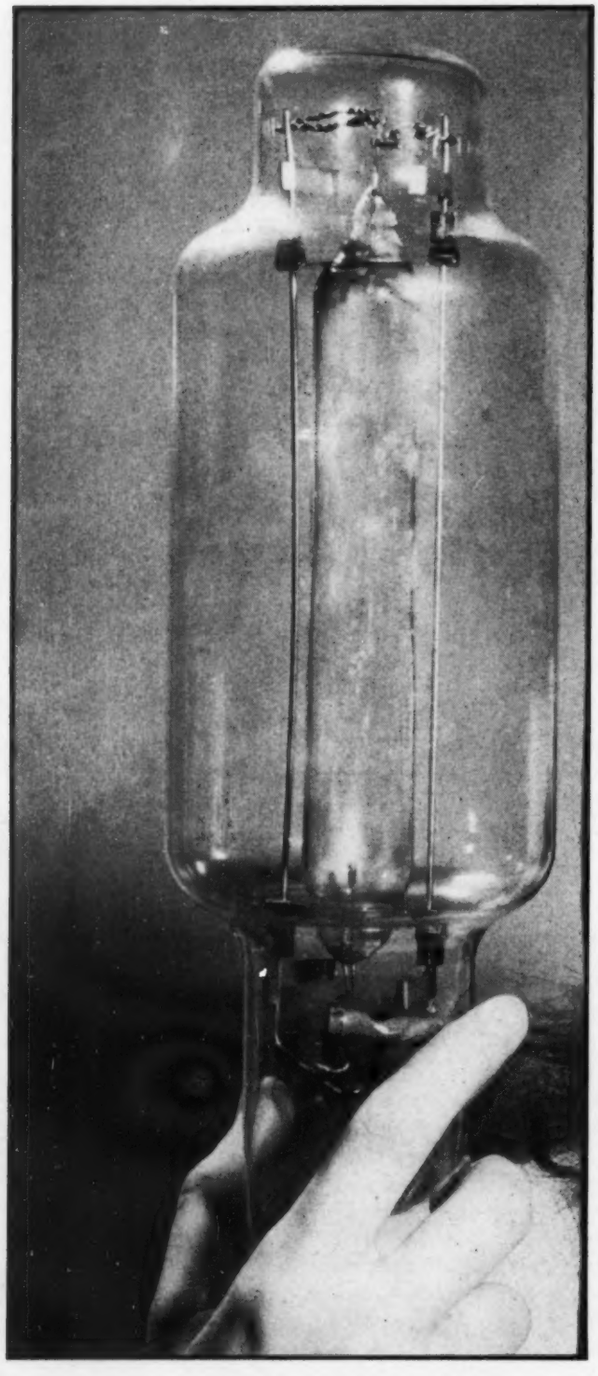
Another possible pitfall in lighting maintenance is the practice of operating lamps below rated lamp voltage in order to obtain longer lamp life and fewer relampings. This practice tends to discourage servicing or cleaning the fixture as often as required, and is not

Presented before A. I. S. E. Chicago District Section Meeting, January 8, 1946.

advisable in production areas. This low voltage condition seems to be prevalent, although it is not always deliberately planned that way. Lamps with properly rated voltage should be used, and copper should be added to the system if necessary. Voltage regulation is another measure which should be applied where needed.

Some industries have found it economical to replace lamps by groups after burning only about 80 per cent of their normal life rather than replace them individually. After 80 per cent life, 20 per cent of the lamps will have burned out, and the remainder will be producing only about 83 per cent output because of deteriorated filaments.

This recently developed 1000 watt mercury vapor lamp gives three times the light of an incandescent lamp of the same wattage.



There are many things to consider in determining the best way to improve an old lighting system, or in installing a new one. Take the apparently simple question of selecting a fixture. Suppose we plan to illuminate a large chipping yard or a similar production area where we need a lot of footcandles. There are several types of fixtures we can use, such as the 400 watt mercury vapor, fluorescents, etc. Let us consider the merits and demerits of two popular numbers, the 1000 watt incandescent unit and the 3000 watt mercury vapor unit. Roughly, the light output of the 3000 watt mercury lamp is six times that of the 1000 watt incandescent. This means that with the mercury unit, there is only one fixture requiring periodic cleaning, as compared to six fixtures of the incandescent type. Of course, the mercury is larger in reflector surface area and possibly has a higher rate of dirt accumulation; nevertheless, only one mercury unit has to be reached.

Another feature is lamp life. The rated life of the mercury unit is 2000 hours. The incandescent life is 1000 hours, which means that at the end of 2000 hours burning, only one mercury lamp will be replaced, whereas 12 incandescent lamps will be replaced. The cost of lamps alone is practically identical considering the total lumen output throughout life. The mercury unit lists at $40.00 and twelve 1000 watt incandescents list at $42.00. The first cost of installation is about the same in either case. However, the mercury may be operated directly off the 440 volt system, thus eliminating the cost of step-down transformers.

On the other hand there are some disadvantages to the 3000 watt mercury unit:

1. It should not be mounted less than 40 ft above the floor because of direct glare from the very bright lamp.
2. Starting and operating below 32 F is unreliable and not recommended at this time.
3. If one lamp burns out, the loss of light in one work-area is equivalent to that of six 1000 watt incandescent units.
4. The 2 3/16 in. diam x 54 7/8 in. long mercury lamps are comparatively unwieldy, especially on top of crane trolleys 50 to 60 ft above the ground. Breaking one mercury lamp is equivalent to smashing two cases of, or twelve, 1000 watt incandescent lamps.

Speaking of fixtures and lamps, it is likely that in a few months we probably will see many new developments, including improved instant-start fluorescent equipment which should be nearly foolproof in operation. And to counteract the disadvantages of the 3000 watt mercury, a 1000 watt mercury lamp has recently become available in about the same physical size as a 1000 watt incandescent lamp.

Another feature which might be incorporated to improve the lighting system is the use of low voltage starting on circuits employing large numbers of lamps. We have not seen nor do we know of any data or records on the benefits of this scheme, but it is now in use and is based on the principle that by imposing a relatively low voltage on the lamp, 50 per cent or less, the initial

instantaneous inrush of current will be appreciably less than at normal voltage where it reaches a value of 10 to 15 times rated amperes. This cushioning effect should prove less of a shock on the filament, particularly with older lamps. After about 15 to 25 seconds of operation at the low voltage, a contactor then applies full voltage to the warm filament, which now has a relatively high resistance and the additional inrush of current becomes negligible. Some operators seem to be pleased with this scheme. Personally, we would like to see some exact operating records.

We have copies of two lighting papers presented at the Iron and Steel Electrical Engineers national convention in Milwaukee in 1912, or 34 years ago. One paper is titled "The Incandescent Lamp in the Steel Industry" presented by Mr. Ward Harrison, who today is recognized as one of the pioneers and greatest contributors to the field of lighting. The other paper is titled "Modern Illumination in the Iron and Steel Industry" by Mr. C. E. Clewell.

It is amazing to know that the principles set forth by these men 34 years ago are still considered good practice today. It is also interesting to note that the footcandle levels recommended at that time were 5 to 10 times those found in actual service. Today, some values found in service are 10 times those recommended in 1912, or an illumination increase of one hundred fold in 34 years time.

Since that time, there have been many refinements, particularly with improvements in light sources and fixtures and from researches in the "art of seeing" which involves the study and application of principles of the relation between light and the eye, that is, efficiency and comfort. The war has retarded coordination in its practical application to lighting systems. And lighting engineers are now working for the answers to the "seeing comfort" problems of lighting, which include the following:

1. Brightness — that is, direct glare from the lamp and the fixture and glare from reflected surfaces, such as metal parts, ceilings, walls, windows, etc.
2. Brightness contrast — in the visual field.
3. Shadows.
4. Quantity of light reaching the eye from the "work" or reading surface, for maximum comfort and efficiency in seeing.

DISCUSSION

PRESENTED BY

W. J. TUNNY, Assistant Electrical Engineer, Youngstown Sheet and Tube Company, East Chicago, Indiana

B. P. FANTONE, Carnegie-Illinois Steel Corporation, Gary, Indiana

W. A. PERRY, Assistant General Superintendent, Inland Steel Company, East Chicago, Indiana

L. A. TERRY, Superintendent Power & Electric, National Tube Company, Gary, Indiana

W. J. Tunny: I would like to ask Mr. Fantone if he had any experience with the birdseye lamp?

B. P. Fantone: My experience with this lamp is limited. A fair appraisal of the lamp can be made only from data obtained in actual field tests; such tests should cover all the factors which are usually investigated when comparing standard lighting systems.

W. A. Perry: I would just like to say a few words about the great increase in lighting. Some of our electrical men in the meeting tonight can recall a time thirty-four or thirty-six years ago when you answered a call on a break-down and you would carry an old tallow pot with a wick on it for the light. At that time, we used arc lights in place of incandescent lamps. One of the big improvements of that day was the flaming arc lamp; and when one of those went out, it was more of a problem finding it than it is now with one of the new modern mercury arc lamps.

W. J. Tunny: As a matter of information, I just wanted to have Mr. Fantone mention what footcandles they use in the mills and also in the offices.

B. P. Fantone: As in all fields of lighting, present steel mill illumination varies from very good to inadequate, with an overabundance of the latter.

The Illuminating Engineering Society is now resuming its study (discontinued during the war) of steel mill lighting. They will make a survey of present footcandle levels and will also study and make footcandle recommendations for each of the visual tasks encountered in every phase of steel making, including office lighting. These recommendations will probably be available sometime in 1947; and there is a possibility that a color motion picture may accompany the report.

L. A. Terry: Mill supervision generally agrees that it is a good practice to regularly clean lighting fixtures to obtain maximum illumination from the lighting investment. I would like to ask if anyone in this group has found a method, or some technique, on how to economically keep fixtures clean, especially with the type help we can get to do this work. Has anyone found out how you are going to get lower paid employees whom you consider safe enough to get on top of a crane to wash lighting fixtures and still be interested in his job to the extent of accomplishing the task?

B. P. Fantone: The problem of obtaining and holding on to manpower for cleaning fixtures is not an easy one. Some industrial plants seem to have solved it satisfactorily by using their own personnel; others contract this type of work to outside firms. The average steel mill employee is reluctant to do this work principally because of the attendant hazards at high elevations and because of the routine nature of the job. To provide a smooth functioning fixture cleaning program, it appears that some form of added incentive is necessary to compensate for the inherently undesirable characteristics of the job.

This paper has suggested how the cleaning cost may be reduced by decreasing the number of fixtures without decreasing the illumination. Booklets put out by various manufacturers should be of further assistance.

Work Light for Steel Mills

. . . . much pressure has been applied in attempts to increase steel mill illumination . . . . why the values now used are often ample is explained by more advanced knowledge on the mechanics of seeing . . . .

by Davis H. Tuck

CHIEF ELECTRICAL ENGINEER

HOLOPHANE COMPANY, INC.

NEW YORK, NEW YORK

▲ SOME fundamentals in lighting that have been well known to the medical profession, biologists and physicists but not known or understood by lighting engineers have recently been discussed at joint meetings of medical men and engineers and in recent books covering biochemistry. These fundamentals are far reaching in their practical application and a brief discussion of their more practical aspects will, no doubt, be of interest to steel engineers.

It appears, that man's natural ego has led him to the erroneous conclusion that when God said "Let there be light" that this directive was given for the primary use of man. Engineers have been trying to simulate nature's abundance of light (10,000 foot-candles in the sunshine) for man's work and play, and although lighting practice at its upper limits is only from one tenth to one hundredth of the sun's illumination, the full value of nature is usually mentioned as the ideal for which to strive.

There is good reason to believe that the purpose of the high foot-candle range of sunlight is for other use than for man's seeing. The energy for the machinery of growth is derived from the sun; the chlorophyll in the green leaf is the mechanism by which energy is intercepted; and the plant is thereby enabled to manufacture food, and to synthesize carbohydrates and proteins from the water and other substances taken up by the roots and the carbon dioxide of the atmosphere. The efficiency of the green leaf is therefore of supreme importance. On it depends the food supply of this planet, our well being and our activities. There is no alternative source of nutriment. Without sunlight and the green leaf our industries, our trade and our possessions would soon be useless. Sunlight also has the important role of supplying vitamin D by irradiation which acts as a catalyst for the conversion of bio compounds of calcium and phosphorous to bone in animals. Without sunlight animals become rickety and in general are in poor condition. Sunlight also, through its radiant energy transformed into heat by absorption, has many of nature's mechanical and chemical jobs to handle. Rain, dew, winds, oil, coal and the cycle of life and decay are a result of the sun's radiant energy. It would appear, therefore, that the upper brackets of natural illumination were not primarily intended for man's direct use in seeing. Instead, man has been endowed with protective devices so that he can endure but not efficiently utilize these high brackets for seeing and on the other hand man utilizes the lower brackets of illumination more efficiently for seeing. Man's principal use of light by the eyes is not for seeing but for orientation, balance, alerting. Man's eyes have two separate and distinct types of light reactors, the rods which fill about 95 per cent of the active (retina) area of the eye and the cones which account for only about 5 per cent of the active area. The rods utilize light for alerting the body and subconscious mind, and this light is necessary for most of our involuntary or subconscious actions. Incidentally, many conscious actions become subconscious by continual repetition. The large majority of the things we do are stimulated by cone action, such as driving a car, walking, eating, drinking, manual labor of all kinds and continual alerting to avoid accidents. We actually see things (recognize detail) by the cones. The rods involuntarily pick up a man approaching us, but it requires an act of the will and cone vision if we want to recognize this man as John Brown. We do not actually see (cone vision) most of the men we pass on the street. We use the rods to pick up a book, sit down in a chair and open the book, and we use the cones to read the book. The rods are much more sensitive to light than are the cones so that we can be alerted under much less illumination than is required to see. This explains why our street lighting (0.025 to 1.0 foot-candles) is satisfactory for its purpose of avoiding accidents. The sensation of color is a function of the cones. The rods do not discriminate color, and this

explains why under low illumination everything looks gray.

If we will analyze our daily work, we will realize how little we really see. In other words, the rods take us through most of our daily work and as we become more and more proficient at our alloted tasks, the rods take over more and more of our actions. As I am writing this, I do not actually see (cone vision) the words. The rods are guiding my hand to a larger extent. When we saw a board, the cones help us get the saw started on the proper line but after that the rods take over and only once in a while do the cones take over to check whether we are following the line or not. Many apparently difficult operations in our daily work which may require cone vision by the beginner are taken care of to a large extent by rod vision in the case of an experienced operator. Some of the jobs that to the unexperienced appear to be exacting and difficult seeing tasks requiring cone vision are readily taken care of by rod vision by the experienced operator. On hand sewing of fine stitches with black thread on black cloth, the experienced seamstress uses cone vision for starting her needle and for checking her work once in a while and for the greater part of the time, rod vision is used. Relatively poor eyesight of older workers is often compensated for by skill which allows rod vision to a greater degree. On the other hand, a younger, less skilled worker will compensate for lack of skill by resorting to greater use of cone vision.

When we light for safety, we are dealing with the rods. As an illustration of how dependent we are on rod action, try to answer these questions about the man who works next to you.

1. What color tie does he have on?
2. Did he shave this morning?
3. Are his shoes shined?
4. What color suit is he wearing?

If you had used your cones when you said "Good Morning, Jim," you could answer these questions.

The rods and cones are receptors which transform light energy into some other form, chemical or electrical and send a stimulus to the brain. The unit of light energy is the lumen hour (L^2MT^{-2} in the antimentergram-second unit system) and corresponds to the unit of electrical energy, the kwhr (L^2MT^{-2}). To convert a foot-candle (MT^{-3}) to a lumen hour (L^2MT^{-2}) it must be divided by the reflection factor of the work, and multiplied by the size of the object (L^2) and by the interval of time it takes to see the object (T).

$$\text{Lumen hours} = \frac{(L^2MT^{-2})}{K}$$

This energy conception of seeing explains in part why small objects and rapidly moving objects require more light to see them. The rods are much more sensitive to motion than the cones, and it has often been observed that the flicker of an incandescent lamp, operating on 25 cycles, can be easily seen out of the side of the eye (rod vision) but when we bring the lamp on to the axis of the eye (cone vision), the flicker disappears.

These conceptions of lighting explain why a steel mill can operate efficiently with the low brackets of illumination that are used, because most of the work is done by the rods and only a small part at intervals by the cones. Figure 1 shows the foot-candle range for many of the more usual steel mill operations found in sixteen steel mills. The vertical arrow shows the average for each operation. The foot-candle values shown are initial calculated illumination and should be reduced by approximately 70 per cent to approximate actual in service values. The reason for the reduction is discussed in the article "Lighting Improvements for Steel Mills," D. H. Tuck, Iron and Steel Engineer, Feb. 1946, page 95. From the tabulation it will be seen that for such operations as chipping and galvanize assorting, where cone vision is required for most of the work, the defect looked for is small and the operation fast, the illumination is much higher than for other operations where rod vision is mostly used and cone vision is used only occasionally.

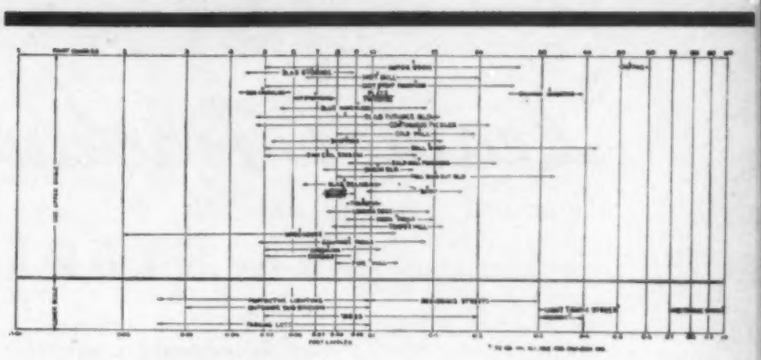


Figure 1 — Chart showing the maximum, minimum and the average illumination for several processes in sixteen steel mills. The horizontal arrows show the maximum and minimum and the vertical arrows show the average illumination. The foot-candle values are initial calculated horizontal and should be decreased by approximately 70 per cent for inservice values.

As a general rule the illumination required for continual cone vision, such as drafting, repair shop, die making, most inspection, is much higher than for locations requiring mostly rod vision with intermittent cone vision such as storage space, pickling, rolling mills, etc. It will be noted that as we pass to locations where rod vision is almost exclusively used, such as outdoor lighting, the foot-candle values are in the lowest brackets.

The tabulation of steel mill illumination values is interesting in connection with the newer concepts of rod and cone vision and the light energy (L^2MT^{-2}) requirement of both rod and cone vision because it shows quite well that present steel mill lighting practice is basically sound and that higher and lower foot-candle brackets have been used correctly as required for the particular work.

Steel mill engineers have effectively resisted the high foot-candle pressure groups due to their own observation and conviction that the current range of illumination represented good practice in representative mills, where the production, quality and accident rate was satisfactory. The wisdom of their decisions is only substantiated by the mechanics of rod and cone vision and light energy considerations.

Leather Packings

FOR HYDRAULIC ROLL JACKS

. . . . a redesign of the packing on the hydraulic roll balance jacks in a mid-western steel mill was found to have several advantages and economies . . . .

by R. W. Justice

E. F. HOUGHTON COMPANY

YOUNGSTOWN, OHIO

▲ A REDESIGNING of the packing installations on hydraulic roll balance jacks can be a step toward eliminating the failure of such equipment, as was shown in one of the largest mid-western steel mills, which two years ago changed the type of packings used.

Failures of roll balance jacks are costly, particularly the labor costs of making repairs, the lag in production during the repair period, loss of large quantities of hydraulic oil from leakage, and scrapping of metal when a finishing stand jack failure causes finished material to be off gauge.

During hot strip rolling, a large amount of hard mill scale and dust is formed and blown from the strip, a considerable portion of which works down into the jack cylinder. Oil or grease closures, such as shown at the top of Figure 1, are only partially effective as sealing media. It is evident that the dust and scale which enter the cylinder will eventually be trapped and held at the outer surface of the cup leather. The leather bearing area is that section of leather surface in contact with the cylinder walls.

After twelve years of operation, the jack cylinders in this particular mill had become worn enough to cause numerous shutdowns because of cup leather failures. With each failure there was a considerable loss of oil from the accumulator system.

The roll balances were operated at a hydraulic system pressure of 3,000 psi, and the hard scale held at the leather bearing area had been pressed into the leather and against the cylinder walls by the internal pressure against the inner cup surface. The effect was a wearing or abrasive action upon both the leather and the cylinder walls.

Failures were inevitable, due to the cylinder wall wear which averaged, upon one roll stand of eight cylinders, 0.062 in. per cylinder. Two cylinders had been worn more than twice this amount, showing oversize dimensions of 0.131 and 0.154 in. respectively. Inasmuch as the standard hydraulic operating clearance of the 3 and 4 in. diameter cylinders should be approximately 0.004 in., the mill delays caused by the roll balance jack failures could not be attributed to any faults in the leather packings themselves.

New equipment was not available in 1944 because of the more urgent needs of the armed forces, and it was decided to rebore and refinish all roll balance cylinders with a ¼ in. larger diameter. The type of seal used, after the cylinders were rebored, was changed from the former cup packing to a set of leather V packings. The difference in the packing application and in the arrangement of the follower plate is shown in Figure 1.

The wisdom of making this change was evidenced by the results. Since the V packings were installed, there have been no mill delays caused by packing failures, nor has there been any loss of oil through the roll balance jacks.

Savings resulting from these repairs and redesign have been tremendous, but it must be acknowledged that not all of the savings can be attributed to the replacement with V packings. Cup leathers and back-up washers used with the refinished cylinders would have resulted in some savings through increasing the operating capacity, but it is doubtful whether the improvement would have been as large as that obtained through the use of V packings. The reasons for such an assumption are given in the following paragraphs.

Referring to the larger cylinder Figure 1, it will be noted that three possible sources of oil leakage exist in this design, apart from any which might be caused by wear or possible failure of the cup leather:

1. Leakage may occur through the cup, due to porosity of the leather, at pressures of 1500 psi or less.
2. The nut holding the assembly upon the piston can rarely be tightened during assembly to a tension equal to the hydraulic force which is applied against the follower plate in operation. A force of 3000 psi in a 4-inch cylinder exerts a total force of more than 37,000 pounds against the assembly in operation. This force squeezes or compresses the back of the cup, as well as the back-up washer, with the result that the follower plate, cup and washer may become

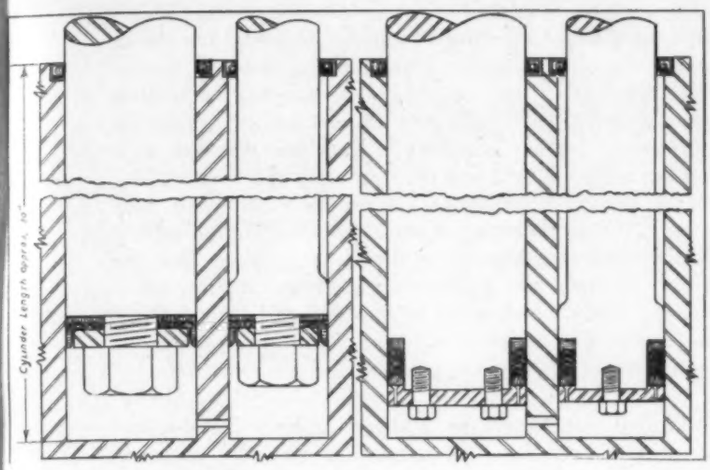


Figure 1 — Piston assembly for roll balance jacks. On left is shown the original equipment with leather cup and back up washer and on the right is shown the altered design with leather V rings and adaptors.

loose and float in a vertical position on the piston. Under such conditions there is the possibility of a pumping action with subsequent leakage.

3. Leakage can occur through the threaded area of the piston, although this can generally be avoided by use of an "O" ring in the bore of the follower plate.

A cup leather consists of but one thickness of leather and contains no operating safety factor. When wear causes a cup leather to begin leaking it is generally the result of a hole through the heel or radius of the cup. In an open end cylinder operating from a large oil supply at a pressure of 3000 psi, the oil loss from such a cup failure may total five to ten drums of oil before the shut-off valve can be closed.

Failure of a cup in operation always requires an immediate replacement.

It should be mentioned that the three possible sources of leakage enumerated are not disadvantages in all systems. In fact, slight leakage might be desirable in some units to provide lubrication to the upper cylinder walls.

There are other type hydraulic systems where even small amounts of leakage or by-passing may be disastrous, as in the case of the type of units containing double-acting pistons. If leakage occurs from the large area cylinder to the small area, the hydraulic pressure of the latter or pull back may be intensified to as much as nine times the pressure in the large cylinder area.

ADVANTAGES OF V LEATHER ASSEMBLIES

The principal advantage of the use of a V assembly is the safety factor provided by its multiple construction. A V assembly will consist of two or more thicknesses of packing, reducing possible leakage due to porosity, and almost completely eliminating the probability of sudden failure during operation. The wear upon a V assembly, and any leakage resulting thereby, will occur gradually, thus permitting tightening, renewal of the elements, or complete replacement during week-end repair or maintenance periods. These factors alone justify the use of the V assembly upon both piston and gland designs for high pressure use. A further advantage which might result from the use of a V assembly, as compared to a cup or U packing, is the possibility of reduced friction upon the cylinder surface and packings.

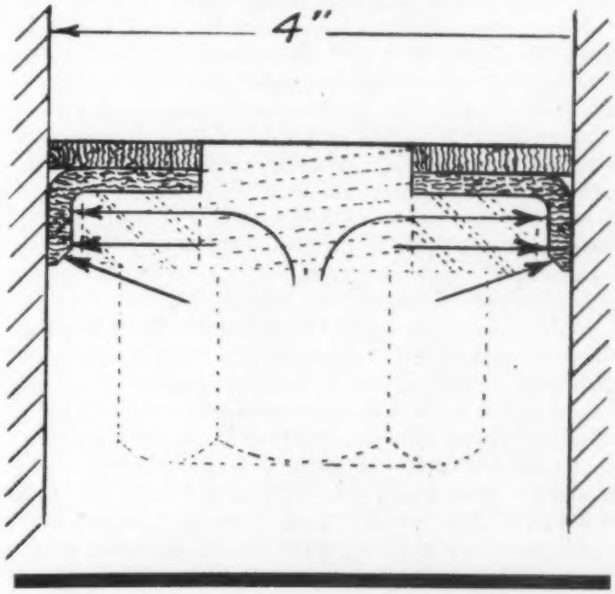
The probable effect upon the side wall of the larger cup leather shown in Figure 1 is illustrated by the arrows in Figure 2. In accordance with the Pascal law of mechanics of fluids that the pressure exerted anywhere upon an enclosed liquid is transmitted undiminished in all directions to the interior of the container, the force exerted upon the side wall of the cup is approximately 21,000 pounds, computed by multiplying the cup side wall area by 3000 psi.

In Figure 3 of a similar diameter V assembly, it will be noted that the cylinder side wall pressure is not directly exerted as in Figure 2. Pressure is exerted vertically against the end area of the assembly, and side wall pressure results from the squeezing or compressive effect of the pressure. The total force exerted vertically against the assembly amounts to the end area of the assembly or 5½ sq in. multiplied by the 3000 psi. The 16,500 pounds total is considerably less than the force applied directly upon the cup side wall as shown in Figure 2.

Further assumption of the squeezing effect upon an assembly resulting from end force may be derived from reference to Figure 4. The end force applied as shown by arrows "A" compresses the leather in the direction of arrows "B" resulting in elongation of the leather in the direction of arrows "C."

It would seem that the resultant pressure against the cylinder walls should be considerably less than that against the cup leather in Figure 2.

Figure 2 — The cylinder pressure results in a large force acting on the sidewall of the cup leather.



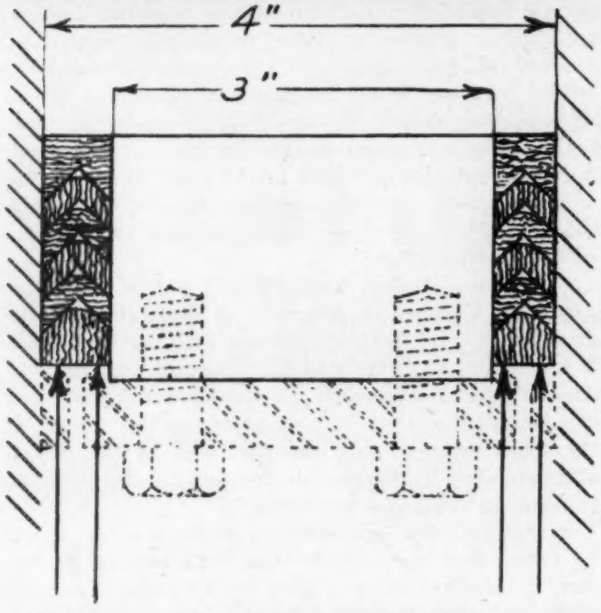


Figure 3 — When V packing is used, the cylinder pressure does not result directly in a sidewall force.

LEATHER VERSUS COMPOSITION PACKINGS

Most composition packings will prevent leakage in hydraulic units by the absence of porosity, thus overcoming one of the disadvantages of the use of a cup leather. Composition and synthetic materials however, contain certain other properties or combination of properties which, in the opinion of many designers and machine builders, make their use less preferable in hydraulic and pneumatic units than is the use of leather packings or assemblies.

The fabric type, rubber surface-coated or impregnated packings have an effect upon piston and cylinder surfaces similar to that of an automobile windshield wiper. The wiping action prevents maintenance of a lubricating film between the rubbing surfaces, resulting in greater friction and wear in the units.

Many types of composition materials swell in operation, due to the solvent or decomposing effect of the hydraulic medium. The close tolerances which must be maintained in a hydraulic packing assembly are such that swelling of the assembly in operation results in binding or actual sticking of the piston.

Many composition materials contain a further characteristic termed cold vulcanizing which, as the term implies, results in the packing surfaces forming a bond with the metal surfaces, with the inevitable result of freezing or sticking of the piston.

Should any of the factors or combined effects listed in the foregoing result in the freezing or sticking of a piston in a roll balance jack, particularly upon the finishing stands, it causes a loss of gauge (non-uniform thickness) in the finished strip or sheets. Variation in gauge thickness or hot finished strip cannot be corrected by subsequent cold rolling, and coils of sheets so affected must be consigned to scrap. Correction of such conditions generally involves an operating delay of the mill to remove and replace the sticking piston.

LEATHER ADAPTORS FOR V LEATHER RINGS

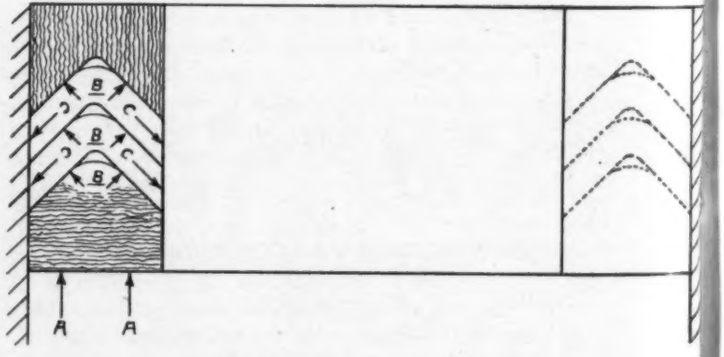
The use of leather adaptors will be noted upon the V leather assembly of the roll balance piston. Many designers believe leather is superior to metal for use in adaptors, since abrasive dust or particles will imbed into the leather and be less likely to score or scratch the cylinder walls. Another important advantage in the use of leather adaptors is their contribution to a uniform stack height and concentricity of a V assembly. Most users of V leathers make bronze adaptors in their own machine shops upon standard type engine lathes. Machinists are seldom required to produce grooved rings, or rings containing angled crowns to the exact concentricity which must be maintained in a V leather assembly. The majority of bronze adaptors so produced will not assemble to the proper precision essentials.

Skilled craftsmen in leather adaptor production acquire a technique in trimming, virtually assuring perfect conformation to the exact stack heights of glands or piston recesses as calculated by design engineers.

A further advantage in favor of leather adaptors is the lower cost of the larger diameters, as compared with the metallic types. The favorable price differential for the larger sizes makes for a lower overall cost of a leather assembly, and brings the cost more in line with that of the low-priced composition assemblies.

Leather V assemblies are not offered as a cure-all for troubles beyond the scope of hydraulic seal correction, but the application of such assemblies is sound, not only from a theoretical viewpoint, but from actual practice and application as mentioned in this case history. The idea is not intended to be revolutionary, but progressive, to utilize modern engineering developments wherever they may be advantageously employed.

Figure 4 — Enlarged view of Figure 3 showing forces which act on the leather packing.



SYMPOSIUM....

Applied Lubrication

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Presented before AISE Philadelphia District Section Meeting, November 3, 1945.

Applied Lubrication

by MAURICE RESWICK

▲ THE purpose of this symposium is to discuss the practical application of modern lubricants to modern machinery. We shall endeavor to present the basic principles underlying the science of lubrication, together with a description of typical lubricants, and this will be supplemented by comments from the several representatives of builders of the equipment and of the users of the lubricants.

PRINCIPLES OF LUBRICATION

We shall begin at the beginning and briefly review the basic principles of lubrication by asking the apparently simple question as to why lubricants must be used. The answer is to prevent or reduce wear on the moving parts of bearings, gears, cylinder walls, etc. Wear is due to friction at the sliding surfaces, which cannot be made perfectly smooth, as shown in the exaggerated sketch of Figure 1. Even the most highly polished metallic surface, when viewed under a magnifying glass, reveals considerable roughness, and when in motion, the projecting parts interlock, tear away, and all this shows up as wear. The only effective way to eliminate metallic friction is to prevent metal-to-metal contact by interposing a fluid oil film between the rubbing surfaces. The entire science and art of lubrication is based on this principle.

Now, a fluid oil film or a plastic grease coating also possesses internal friction when in motion, although considerably less than the solid friction of dry metallic surfaces. The second principle of lubrication, therefore, is to use the lightest oil or the softest grease that will prevent metallic contact under the particular operating

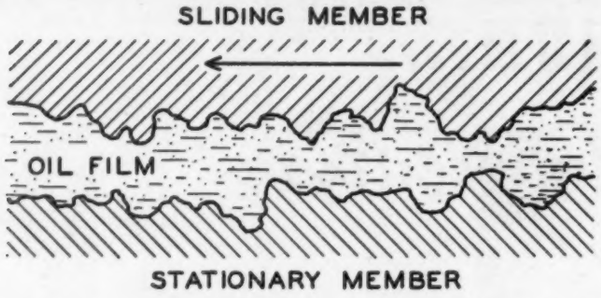


Figure 1 — Exaggerated view of motion between two pieces separated by an oil film.

conditions. For this reason we have a variety of oils from light to heavy viscosity as well as greases from semi-fluid to hard consistency. Depending also on the operation requirements, these oils and greases are available in various degrees of quality and with special purpose characteristics. As examples, we might cite turbine oils, general machinery oils, gear oils, extreme pressure lubricants, and greases; some to resist water, and others to resist heat.

In Figure 2, we show in four "slow motion" steps what takes place in the lubrication of the most important machine element, a plain sleeve type journal and bearing, the clearance between the journal and the bearing provides for the formation of the oil film; the oil has an affinity for the metals, adhering to the surfaces; while the journal and the bearing when in relative motion act like a pump. In the position at rest under load, the film is very thin, the only oil present at the contact area being not more than that absorbed into the crevices or interstices of the metal. As the journal starts to revolve, it pulls the adhering oil from the top by wedge action until it rides on an oil film of substantial thickness. The exact position of the line of greatest pressure in the bearing depends, of course, on the load and also on the relative speed of the journal.

The quantity of oil necessary to maintain a film to separate the moving metallic surfaces is indeed very small, but for efficient lubrication, we use in practice many, many times this quantity, the reason being that it is necessary to sweep away or remove the heat generated from the internal friction of the oil as well as the heat transmitted to the bearing from other parts of the machine, such as from the steam in turbines, electrical windings in motors, etc. This is the reason why extensive circulating systems with large reservoirs of oils are in use to lubricate high speed precision built machinery bearings.

LUBRICATION OF BALL AND ROLLER BEARINGS

Ball and roller bearings are in extensive use for the reason of their precision alignment, interchangeability, favorable starting condition, low servicing attention, and low frictional losses, deservedly justifying the name of anti-friction bearings.

The difference between an anti-friction bearing and a plain bearing is much the same as between a sled and a cart. A sled can be moved easily over snow or ice, serving as the lubricant, which corresponds to an oil film in a plain bearing. The wheels of the cart do not slide, but roll on the ground, with practically no friction between the wheel and the road.

In ball and roller bearings, we have theoretically a point or line contact. Actually, the contact is not a point or a line, but a spot or a narrow rectangular surface. This is due to the fact that all materials are more or less elastic, and a certain amount of elastic deformation takes place. The action is similar to that of a rubber tire on a car running over an asphalt pavement on a hot summer day; the road gives and the tire flattens out at the same time.

Figure 3 shows in exaggerated form how a similar action takes place in the elements of an anti-friction bearing. The races are slightly (though perhaps invisibly) indented along the line of greatest pressure, the roller assumes a slightly elliptical shape, while slight ridges form on the surface of the races at either side of the roller. Since we now have surface instead of point or line contact, it is obvious that sliding takes place which must be counteracted by lubrication.

Bearings, as they are built now, consist of an assembly of balls or rollers in a cage. The balls or rollers revolving about the races, must, of necessity, slide where they touch the cage or retainers, and here we have straight friction. Hence an important function of the lubricant is to cause the balls or rollers to slide against the retaining cage on a lubricating film. Bearings are also constructed without retaining cages, but in such construction the balls or rollers rub against each other, and the lubrication problem becomes even more important.

The construction of roller bearings is usually such that the rollers revolve about the inner race within grooves between raised shoulders. There is, therefore, considerable sliding friction between the end of the rollers and the guiding shoulders, which must also be lubricated.

We have shown that an appreciable amount of friction exists in so-called "anti-friction" bearings, and the purpose of the lubricant is to reduce this friction to the lowest possible minimum and also to carry away the heat. If a ball or roller bearing were run without lubrication, the friction would develop sufficient heat to destroy the bearing.

We have pointed out that in ball or roller bearings the lubrication requirements are not as severe as in a plain bearing. On the other hand, ball or roller bearings have a large number of parts, and the life of the bearing is no greater than the life of any single ball or roller, very much as a chain is no stronger than its weakest link. Once a ball or roller or some portion of the retainer or races gives way, the entire bearing is quickly destroyed and must be replaced.

One of the principal advantages of anti-friction bearings is that they lend themselves to lubrication with a suitable grease, which, on account of its stay-put properties, does not leak away, and requires only occasional attention for refilling. Bearings in electric motors about a steel mill should not be repacked with grease oftener than every six months, although they should be inspected at more frequent intervals to detect any accidental irregularity.

High speed motor bearings and small and medium sized bearings in general, should be packed with special

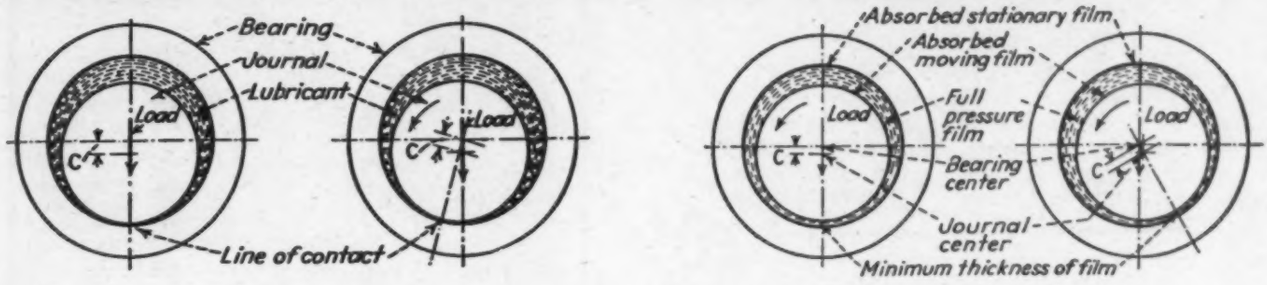


Figure 2 — As the journal starts to rotate in the bearing, it starts to climb as shown in the second view. However, as the oil film is pumped into the bottom of the bearing, the journal slides back as shown in the third view. At high speeds, the pumping action may move the contact point to the position shown in the fourth view.

ball bearing grease, and never with ordinary so-called cup grease. The bearings should not be filled more than one-quarter to one-third full, as too much grease causes excessive internal friction due to the churning of the grease, and may cause the grease to be thrown out on the windings of the motor, which will dissolve away the insulating varnishes on the windings and eventually cause the motor to burn up by short-circuiting.

Grease is made of mineral oils thickened with certain soaps. Soaps are made of animal fats, such as beef tallow, by boiling with lime or soda. A familiar form of lime exists as "white wash," while a familiar form of soda is "lye." A grease made out of a soap with a lime base has the property of not mixing with water, but it softens under heat and under very high speed it may give up the oil, so that all that will be left in the bearing will be a hardened mass of soap which has no lubricating properties. A grease made of soda base soap, if properly made, will withstand high temperatures without melting and will also resist separation of the oil under the action of speed or agitation, but soda base greases have the disadvantage of absorbing water.

For high speed ball or roller bearings, therefore, one should always use a high grade soda base grease in moderate quantities. The same grease should also be used on roller bearings of conveyors near furnaces as well as other applications where high temperatures are involved.

Roller bearings on roll necks revolve at a comparatively slow speed, and there is usually considerable water on the rolls which finds its way into the bearings in spite of all precautions and sealing arrangements. The main requirement on such bearings is to use a grease that will not mix with water, and for such applications the universal practice is to use a soft lime base grease, preferably one made up with a heavy-bodied oil. On roll neck installations, the function of the grease is not only to lubricate the many bearing elements, but also to keep out water and mill dirt.

Roll neck bearings operated at a comparatively slow speed may be kept full of grease at all times, but on high speed strip mills, the latest approved practice is to keep the bearings only partially full with grease, in order to avoid excessive internal friction. Usually overflow openings in the bearings are provided which give an idea about the quantity of grease fed into the bearing. A good roll neck roller bearing grease, in addition to being water repellent, should also possess sufficient tackiness to adhere to the bearing elements and form a protective coating against water rust.

Tremendous pressures are involved in rolling steel, and it frequently happens that a peak load occurs which exceeds the normal capacity of the bearings. To take care of sudden overloads and prevent the roller bearings from breaking, experience has shown that the grease used for lubrication must possess special load carrying properties, or extreme pressure characteristics. To meet this condition, greases for roll neck bearings must be specially compounded with certain materials which impart extra film strength to the grease. Whether or not an extreme pressure grease must be used on roll neck roller bearings may at times be questioned, but considering that the increase in cost over an ordinary grease is but small, and that the bearings are very expensive, it certainly pays to use an extreme pressure grease on all such installations. Experience has shown that when an ordinary grease was changed to one having extreme pressure characteristics, breakage of bearings was greatly reduced.

EXTREME PRESSURE LUBRICANTS

In normal lubrication, which is more than 99 per cent of all applications, the oil film which separates the metallic surfaces in relative motion, is sufficiently strong to resist breaking under the load. Due to limitation of design or abnormal operating conditions, the unit load on bearings or gears frequently exceeds the film strength of the oil, and in such cases extreme pressure lubricants should be used, which have a film strength or load carrying capacity from five to seven times greater than that provided by mineral oils.

An extreme pressure lubricant bears the same relation to a straight mineral oil as an alloyed steel bears to straight carbon steel, the addition of compounding to the oil or the alloying agent to the steel imparting increased strength and serviceability in both cases. Various ingredients are used as additives to mineral oil as extreme pressure agents, the most widely used being lead naphthenate, which is a soap made up with metallic lead and naphthenic acid, derived from certain petroleum crudes.

The real criterion of the efficiency of an industrial extreme pressure lubricant is its record of plant performance. However, a relative indication may be

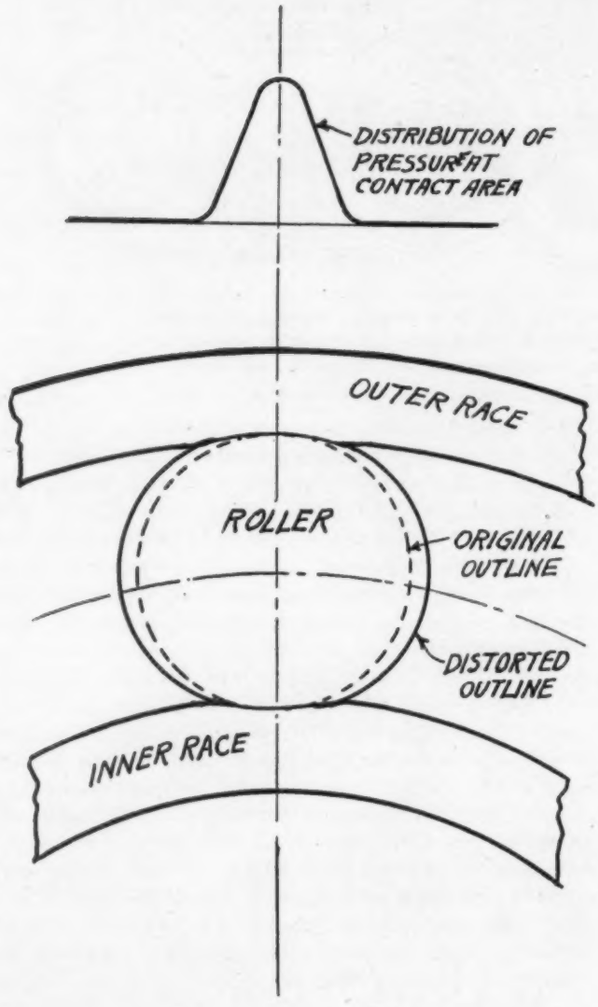


Figure 3 — Sketch indicating the deformation of a roller bearing under heavy load, and the pressure distribution over the contact area.

obtained by means of laboratory testing machines. There are several such testing machines, but the one which is best known to users of industrial extreme pressure lubricants is that developed by the Timken Roller Bearing Company, and shown in Figure 4. In this machine, the outer race of a Timken roller bearing of 6 in. circumference is rotated at 800 rpm, or at a surface speed of 400 feet per minute, against a rectangular steel test block, with a flow of the extreme pressure lubricant directed at the rubbing contact area. The load is applied on the steel block by means of a lever and knife-edge arrangement, and the machine is run for 10 minutes at the end of which the condition of the cup and test block is noted. If there is no pick-up of metal or scoring of the block another new surface is turned up and a new cup is used for another test at a heavier load. If there is evidence of failure, the test is repeated under a lighter load. The Timken Roller Bearing Company defines a satisfactory industrial extreme pressure lubricant as one that will carry a minimum O.K. load of 33 pounds on the lever without scoring either the rotating cup or the test block and this definition receives general recognition among users of such lubricants.

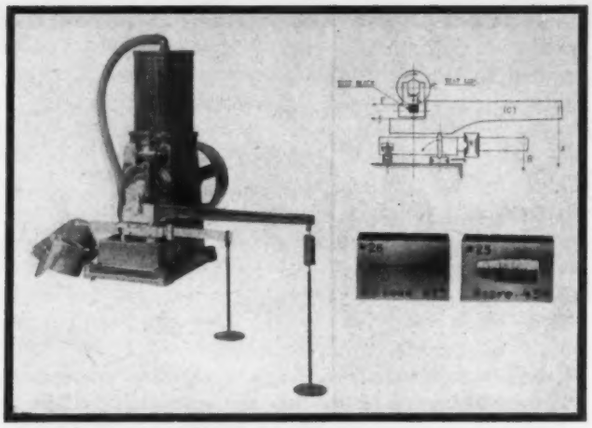


Figure 4 — The Timken lubricant testing machine is widely used to determine the efficacy of lubricants for industrial applications.

Test results on this machine have illustrated the difference in load carrying capacity between a straight steam refined mineral oil and an extreme pressure lubricant employing the same oil compounded with lead soap, both lubricants having the same viscosity of 150 Saybolt seconds at 210 F. At the prescribed test speed of 400 feet per minute on the Timken machine, the mineral oil carried 4,600 pounds psi, while the extreme pressure lubricant carried 28,000 pounds psi, or more than six times the load before scuffing or abrasion took place.

The logical use of extreme pressure lubricants is in places where the equipment is normally overloaded, subjected to occasional peak loads resulting in high localized pressures. They are not intended for gear drives in which the load on the teeth is about 500 pounds per lineal inch of face or less. On loads exceeding 1000 pounds per lineal inch of face, extreme pressure lubricants are mandatory.

LUBRICATING SYSTEMS

Old time machinery was provided with an oil hole or a grease pocket in the bearing cap, and the oil can or grease paddle was an inseparable part of the machine. The next step in efficiency and economy was the sight feed oiler, followed by the pressure feed oiler, which is still a component part of every steam engine. Modern machinery is built with oil-tight reservoirs for gears and bearings, and elaborate circulating oiling systems. The tendency today is toward automatic lubrication, for both oil or grease. The principle involved is that of supplying a measured quantity of lubricant at proper intervals of time in the most efficient and economical manner.

ADDITIVES IN OIL

We have already mentioned one type of additive to oil in discussing extreme pressure lubricants. There are many other additives which are used to impart special

properties, but we shall confine ourselves to oils which have been inhibited against oxidation and corrosion, as applied to turbines, and to oils containing detergents and dispersion additives as used for the lubrication of diesel engines.

A steam turbine is a sensitive machine from the standpoint of lubrication and requires an oil of the highest quality that will resist oxidation, emulsification with water, and retard corrosion of the metal parts of the system. It is impossible to prevent intrusion of moisture into the oiling system, but it is possible to reduce or eliminate metal corrosion by adding to the oil an ingredient which increases the wetting ability of the oil and thus prevents the moisture from coming in direct contact with the metal and cause corrosion.

Mineral oils, no matter how highly refined, have a tendency to deteriorate more or less, as evidenced by an increase in viscosity, formation of organic acids, sludges, and other effects. To prevent the formation of objectionable oxidation products, oils for modern turbines are inhibited against oxidation, in addition to being inhibited against corrosion.

The effective lubrication of diesel engines presents a distinct problem. Due to the incomplete combustion of the relatively heavy fuel oil, it was found that carbon and soot deposits accumulate, causing ring sticking and eventually scored cylinders. A straight mineral oil does not possess sufficient "washing action" to remove these deposits, and the problem was solved by adding to the oil ingredients which readily dissolve the solid deposits that cause ring sticking, varnishing and the formation of sludges. Such oils are referred to as "detergent types."

The action of these additives is not only that of detergency, but also that of dispersion, that is, of holding in suspension the solids and of preventing the coagulation of the fine particles into harmful larger masses, which may hinder the free flow of the lubricant. Detergent type oils of good quality are also inhibited against corrosion of copper-lead bearings.

Additives in Oils

by WILLIAM P. KUEBLER

▲ ONE additive that we learned about quite a number of years ago, and one of the first additives, was the pour-point depressant, in which you could take an oil that had a pour-point of 30 or 32 degrees and by adding 1 per cent of the additive you obtained a pour-point of zero. It was used for a while, and is still used now.

Then we started using the extreme pressure additives. I am going to mention one or two applications of extreme pressure additives or additives with wetting agents in them. We have many large planers. One of them in particular is a Betts planer with a 21-foot way. While that planer is designed to take possibly a 14 or 15 foot stroke, invariably most of the time it takes a 14 or 15 inch stroke, and when the 500-second oil that is specified by the manufacturer for that planer is used on a 14 or 15 inch stroke, we do not get any lubrication in the bed of the planer, in the ways of the planer, and we have found that we had some scoring. We found that using an oil of 380 to 400 seconds, with a wetting agent in it, gave us the lubrication that we wanted on the planer way, particularly on short strokes. We use it, of course, when we are doing long-stroke planing.

It hasn't been so many years ago that on our gear-hobbers we were using just a 200-second red engine oil. We had light loads, or I mean the castings or gears that we were machining were light in weight and we hadn't any difficulty.

Then we started to put on heavier gears and soon the gear hobber tables started to chatter and, of course, we had a little cutting oil cut into it also. We then went to a 300-second oil. Then our load became still heavier so that at the present day on our gear hobbers, and where we are machining anything from a small pinion up to a 16 foot bull gear, we are using a mineral oil with a wetting agent in it at 650 seconds viscosity, not an extreme pressure lubricant, but just a wetting agent to wet the surfaces and to give us persistency of film.

There is another application where we use an extreme pressure lubricant and a wetting agent. We make turbines and we make turbine rotors and most of you men know that the blades on the turbine rotors are driven on the rim and the clearances there are such that possibly there is only a half thousandth difference between the inside dimension of the turbine blade and the outside dimension of the rim.

Castor oil had been used for quite a number of years. With the scarcity of castor oil, we were forced to find a lubricating oil that would give us a satisfactory answer to the problem and in that particular application, we use an oil with a wetting agent in it, an agent that gives it film persistence, and in addition we have a lubricity agent in it.

Now there is another additive that resists or reduces foaming and that is particularly important in modern, highly refined turbine oil.

The next additive is one for oxidation inhibition.

The fourth additive is an additive to prevent rusting. The modern, highly refined turbine oil has practically no impurities in it. The result is that when moisture gets into the lubricating system, particularly when your system is new and your oil is new, the water displaces the oil and rusting occurs. It isn't a red iron oxide rust, but a black, magnetic oxide of iron rust.

M. D. Baker, chief chemist of the West Penn Power Company, and myself, were the co-discoverers of the fact that oils allow rust. The conclusion was that the oils lacked wetting ability. We found that all oils that we examined, some 40 or 50 turbine oils, irrespective of their source, whether they were coastal, mid-continent, Pennsylvania, or paraffinic, if they were highly refined they allowed rust to form. Now the modern turbine oil has been designed to last 10 or 12 or 15 years in the turbine and these turbine oils, although they are highly refined, do have a little minute particle of impurity in them and it is that impurity, when it mixes with air and water that becomes oxidized and starts to

grow. The neutralization number grows and eventually that oil will inhibit itself insofar as rusting is concerned. It will build up its own wetting characteristics, but with the modern oil, that may take 9,000 - 10,000 hours before the oil is in a condition to resist displacement by water.

Our first step in endeavoring to do something about this was to add some old oil to the new oil and we did stop rusting, but we also reduced the other so-called desirable characteristics of the oil. Then we suggested to some of our customers who didn't know what to do about it in the case of a new turbine, that they take the old oil from an old turbine and put it in the new turbine and put the new oil in the old turbine. This showed that there would be enough film deposited on the walls of the old turbine to resist or to help the wetting ability of the new oil, and that the old oil in the new turbine would have its own wetting ability, so that when water got into the turbine it wouldn't rust.

That wasn't desirable either but I might say that all the refiners now have very fine inhibitors against rusting that have very little effect on any of the other characteristics of the turbine oils. The refiners are to be congratulated on having done a job well on that particular aspect of lubrication. In addition, we use nothing but rust-inhibited oil in our plant.

Lubrication

OF RECIPROCATING STEAM ENGINES AND STEAM HAMMERS

by F. C. SCHOEN

▲ IN reciprocating steam engines, manufactured prior to 1920, we find few units totally enclosed over crank and crossheads with forced or splash feed oiling. Instead, everything is wide open to all the dirt and other foreign material to be found in a steel plant. We find in general, very ample bearings with quite low bearing pressures usually in the range of 750 to 800 psi for the designed working pressure. In many cases, since installation, there has been a tendency toward higher steam pressure with consequently more work from the units. This, of course, has raised bearing pressures up to the range of 1000 to 1100 psi.

With the above facts in mind, it is easy to see why better oils or greases are becoming necessary on the reciprocating parts of old engines.

The steam cylinder is still another portion of a steam engine to be lubricated, and perhaps it should have been covered first from the standpoint of importance. Improper lubrication at this point can cause serious damage which will not become apparent until trouble develops.

In a reciprocating steam engine then, we find the following points requiring various types of lubrication. Steam cylinders and valves, crank, crosshead and crankshaft bearings, crosshead slides, eccentrics or link motion, valve gear, indicator and revolution counter linkage, governor and governor gearing or drive. No other mention will be made of the last five items since they generally have squirt can or grease cup lubrication requiring little more than average care on the part of the engine room operator.

In looking at the other two items, we will first discuss the steam cylinder and valves, where the type of lubrication used is partially governed by the temperature and moisture content of the steam, for dry steam will not wash away the lubricant while a wet steam will. We have found it good practice to periodically remove cylinder heads for internal examination, especially if a new cylinder oil has been put in stock, which is supposed to be just as good as the one we were using. On examination, a smudge or smear of oil obtained by rubbing a white paper over cylinder wall is usually an indication that sufficient oil is reaching the cylinder. An engine having speed control through use of a throttling governor valve, can usually get along with a lower percentage of compounding in oil than one which is governed by valve stroke.

The second item, crosshead, crank, and crankshaft bearings, may be lubricated several ways, using grease cups, especially in slow speed units which are gravity oil feed, or forced feed through drilled shaft, or splash feed. Little need be said about the use of grease. Usually, as soon as trouble develops, an oil system is installed. The gravity system with sight gauges is only as dependable as the engine room operator. The splash and forced feed systems have a big advantage in that oil remains cleaner and in general, units need less attention. With forced feed systems, care must be taken that too heavy an oil is not used so that bearings farthest from the pump are not starved. Greater attention to uniform bearing clearance is also needed as those bearings with greatest clearance will obtain more than their share of oil.

The following will discuss several case histories and explain the reasons for the present lubrication set-up.

First, all units discussed operate from a works steam pressure of 150 lb saturated, although their original designed working pressures vary from 90 to 130 psi.

Case 1 — Three cylinder simple engine direct connected to high pressure hydraulic pump. Speed 50 rpm, 45 in. bore × 48 in. stroke. Four main bearings, four piece babbitted, wedge adjustment, journal size 22 × 28 in. long, crank bearings two piece babbitted, journal size 14 × 18 in. diameter. Bearing lubrication, gravity feed from overhead storage tank fitted with cooling coils. Oil flows to connecting rod bearings, main bearings, crosshead pin and crosshead shoes. Drain is from crankpit to below ground collection tank, and is then pumped alternately to two oil and water separators from which it runs by gravity to cloth type filters, from which it is pumped to main storage tank. Total oil in system is approximately 1000 gallons. The oil used is a turbine oil with viscosity of 311 at 100 degrees, 55 at 210 degrees, pour test 10, SAE number 20 and demulsibility of 1620. The background of our oil choice is as follows: Since the engine drives a pump which will leak

and on which packing may blow out, it was necessary that oil which would readily separate from water be used, for an emulsion could form which would quickly put a gravity system out of operation with a possible bearing loss. Since the unit was highly important, it was felt that cooling of the oil was necessary, so an oil with fair pour point was chosen.

For steam cylinder lubrication, a cylinder oil using a straight cylinder stock compounded with 6 per cent acidless tallow and having a viscosity of 2100 at 100 degrees, and 143 at 210 degrees, is being used. When cylinder heads are removed for periodic examination, we find cylinder walls in good condition with a fair film of oil. Since we are using saturated steam, and since this engine has speed regulation working through the valve stroke, water carry over can be severe on sudden full valve opening, washing all lubrication out of the cylinders. We introduce oil at four points, in front of engine stop valve, and immediately ahead of each steam chest.

Four or five years ago, we experienced excessive wear on our piston rods and tail rods which are 8 in. in diameter. We also had excessive leakage of the metallic gland packing. In an effort to overcome this condition, a six feed force feed lubricator was installed, one feed for every set of packing.

Steam cylinder oil of same specifications as above is used for lubrication, primarily to keep only one grade of cylinder oil in the engine room. This lubricator installation greatly reduced leakage and wear.

Case 2 — This engine is a single cylinder vertical, developing about 300 hp at 150 rpm, and uses cylinder oil of previously mentioned specifications, due to the fact that the unit is at the end of a long line, and even with a good separator, it is not unusual to see water trying to come out of all cylinder joints. The real problem on this unit was in the crank and crosshead bearings; we had pressures in the range of 1450 psi, and used a summite metal bearing with light oil, heavy oil, water and generally a stream of air to keep it cool. A redesign of these bearings increasing their size appears to be the only answer and then a good grade of oil will work. At the present, the new bearings have only been in operation a few weeks, so results are not conclusive. We are starting with a stock item of lubricating oil of the following specifications: viscosity 530 at 100 degrees, 66 at 210 degrees, pour point 0 degrees, SAE approximately 30.

Case 3 — On two other engines driving mills for rolling of rings, bronze bearings are used with a grease applied by hand cups on both crank pin and main bearings. The bearing pressures developed on these two engines at full steam pressure are approximately 1050 psi. It would be possible to install gravity type oil feed, but special collection pans with drilling of frames for drains would be necessary. Engines are brought to a stop for every piece and runs are of short duration. A lime base cup grease is being used and bearing trouble is minor, so any saving by changing to oil is problematical.

Case 4 — In this engine room we have three units, one a 1500 hp single cylinder vertical, the second a three cylinder compound flywheel type pump, and the third an electric driven duplex pump. All units receive lubrication of reciprocating parts from a single gravity system, with return through pipes and troughs to an underground receiver. All units have ample bearing surfaces and practically any oil would serve.

However, in the winter time, feed lines become extremely cold, so an oil with a good pour point is needed. Secondly, all units are driving pumps, so water contamination is a serious problem and it is necessary that oil separate easily from water. With these facts, it was decided to use an oil of the following specifications, at a cost of approximately $0.55 per gallon: viscosity 311 at 100 degrees, 55 at 210 degrees, pour point 10 degrees, SAE number approximately 20. Total oil in system about 600 gallons. After starting with this oil, we found operating costs rising. Further investigation disclosed that 100 to 150 gallons of oil per week were being added to the system to supply make up for oil washed away when packing blew out, and oil lost when cleaning filters and separators. We then decided to substitute a cheaper oil, since by addition, the oil was completely renewed in the system at least every six weeks, and there was little chance of oil breakdown or undue concentration of foreign material. As a result, we now use an oil of the following specifications which costs only 45 cents per gallon: viscosity 530 at 100 degrees, 66 at 210 degrees, pour point 0 degrees, SAE approximately 30, demulsibility 1620. The slightly higher viscosity did affect operation and in cool weather the lower pour point was a benefit.

Case 5 — On our steam hammers which are single and double frame double acting, ranging in tonnage from ½ ton to 10¼ tons, the only lubricant is a steam cylinder oil. This is forced into steam line by a hand pump in most cases, and the hammer crews also use it to swab the ram, their dies or anything else they think needs grease. Accordingly, a cheap lubricant consisting of straight cylinder stock with no compounding was used.

In general, this lubricant proved satisfactory, only two cases turning up to give trouble. In both instances, the trouble was apparently the same, the hammers were located at or near the end of a line, and the steam was very wet. The first indication of trouble would be a tight operating valve and then a jumpy hammer. Automatic lubricators operated by the hammer valve motion failed to overcome the trouble, and finally a cylinder oil of same specifications as used on the engines was substituted. As previously mentioned, the specifications included 6 per cent acidless tallow compounding. The higher percentage of compounding which prevented washing away of lubricant from valves and cylinder walls cured this particular hammer problem.

As stated earlier, the data just submitted is only what we have done, in many cases dictated by what we were able to do when we were in trouble, and now we are afraid to change until we get into trouble again. I can say that during the heavy production of the war period, delay caused by bearing failure of any nature on important units was unknown. This may have been luck, but part of it we think was good practical lubrication.

Standarization of Lubrication . . .

by W. A. SMILEY

▲ IT has always been a matter of wonder to me that most lubricant makers do not issue catalogs. The claim has been made that to give technical data would result in small benefit to the user of lubricants, and in positive harm to the supplier by exposing him to his competitors. This policy seems to me rather inconsistent in view of the fact that a competent chemist is capable of making an analysis. This analysis is most likely to be made by a petroleum chemist in the routine employ of a competitor, rather than by the user of lubricants, thus placing the information in the hands of those parties who can use it to the disadvantage of the supplier and withholding it from the prospective user.

It is not my thought that every detail as to composition of non-analyzable secret compounds should be given, but we should know whether the product includes corrosion inhibitors, antioxidants, oiliness compounds, extreme pressure compounds with the type, anti-wear agents, detergents, etc.

Another claim is to the effect that no amount of catalog information would sell another ounce of lubricant. My own experience has not confirmed this view. Recently a small lubricant catalog was placed in my hands, and in going through this catalog, my attention was drawn to a rather unusual lubricant. Investigation and trial has resulted in our continued and satisfactory use of this lubricant, but not for lubricating purposes, but rather to replace a special type of paint.

In the final analysis, your catalog is your silent salesman always at hand to supply information immediately at the demand of the user, who otherwise would be compelled to wait weeks or maybe months until a salesman (probably a competitor), could secure and furnish what was required.

This constant search for information and still more information has given birth to a series of publications devoted entirely to new developments, products, machinery, tools, equipment, supplies and the like, but I have noticed that only of late the lubricant manufacturers have allowed their products to be included.

Another problem in lubrication occurs when lubricants are specified by machinery manufacturers.

Recently we bought certain machines and on one machine there is a specification for a lubricant oil, where the oil normally is good for 5 years at a conservative estimate. On the other machine, the oil, it is stated quite definitely, was short-lived and bore the instructions, "Change it every year." Now here is a case where the machine manufacturer furnishes definite, concise, complete information on the requirements for lubrication.

However, we have had cases where the machine manufacturer specified a lubricant which was completely unfitted for the job and which if applied in copious quantities would utterly ruin the machine. So the machine-builders are not always going to be in position to supply the operator with the information he requires.

Others could multiply these illustrations a hundred times, and they are mentioned to illustrate the fact that we must have more information about lubricants.

The Association of Iron and Steel Engineers many years back took certain steps which later resulted in the founding of the National Safety Council. In the early days of the Association of Iron and Steel Engineers, the only motors we had were railway motors. Later on, NEMA brought out their own design of motors and then the Association of Iron and Steel Engineers standardized their motors.

Now, why have the Iron and Steel Engineers not standardized the most important thing which is used in their industry or any other industry, namely lubrication practice. It has been said that it can't be done. It has been done, again and again. When you drive an automobile up to a gasoline station and order some 30 oil you are buying an oil which has been standardized by the Society of Automotive Engineers. The man lubricates your wheel bearings with a wheel-bearing grease and your transmission with a transmission grease and your spring shackles with a special grease which is adapted to rubber. Then, there is hypoid grease, high pressure grease, and each one has its own specific use, This is a case of standardization which really works out.

Recently, I had a friend search through the government specifications of lubricants, of which there are about 803 different specifications. As a result of this search, he found only one lubricant specified by name of product and maker. Many companies can supply a lubricant which is adaptable to a given purpose. If the user knew what to specify, he could perhaps get the right item for the right place.

Lubrication

OF BALL AND ROLLER BEARINGS

by A. S. MURRAY

▲ THE matter of standardization is really quite important and touches upon problems requiring the cooperation of the machine builders, the bearing manufacturers, and the users.

The problem is somewhat like a circle — you hardly know where to begin. As a matter of policy we try very strongly to avoid naming any specific product for the lubrication of our bearings. We do that not because we couldn't, but because in many cases we might unnecessarily introduce another lubricant into a plant that has not previously had a need for it.

Specific "Trade Name" recommendations develop multiplicity of different lubricants. We know the problem can be standardized to a certain extent, because we have consistently tried to adhere to a general outline of lubricant requirement or a specific product when absolutely necessary, but always with the accompanying notation "or equivalent." Now then, that gets us into trouble too, because when we try to avoid naming a

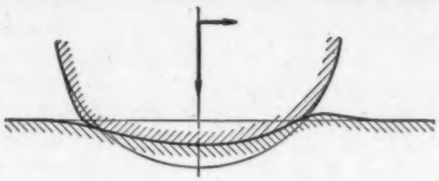


Figure 1 — Deformation, in a radial plane, at the contact point between a rolling ball and its raceway occurs under load.

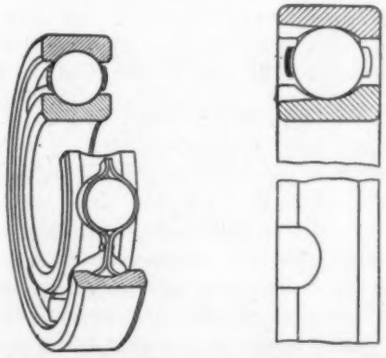
specific product, some say they don't want to rely on their own judgment because if they don't pick one that we consider equivalent, then we have no responsibility to help them. That really isn't true because no reputable bearing manufacturer makes arbitrary decisions such as that.

The way of standardization is really very difficult. The bearing industry has standardized many things and we find it difficult to get all the manufacturers to agree because they have to be rather certain of themselves to be willing to say in writing: "Our products will do thus and so under certain conditions and they are the equal of our competitors' equivalent." There are a great many bearings that are dimensionally interchangeable and part of the bearing system may be incorporated in the number. The bearing numbers of certain bearing manufacturers are descriptive and they indicate a degree of interchangeability.

During the war we have struggled as an industry, through our association, to develop a broader standardized system for identification of bearings so as to make it completely above the different trade numbers now used by each of the various manufacturers. This is a difficult job because it means that many of the established practices, that now go on and guide daily routine, will be affected. For example, Mr. Schoen's paper pointed out that they didn't want to change specific maintenance practice unless they had trouble, and that so long as an important machine was running well they were going to leave it "status quo" until they had to change. Now when you multiply that case by all the

Figure 2 — (Left) Single row ball bearing without filling slots.

Figure 3 — (Right) Single row ball bearing with filling slots.



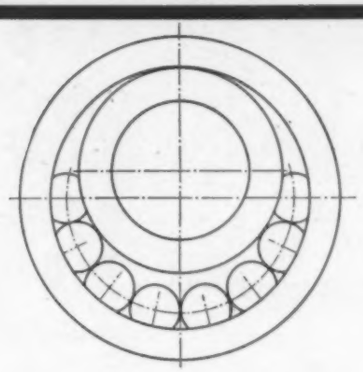


Figure 4 — When a single row bearing without filling slots is used, the balls are loaded as illustrated.

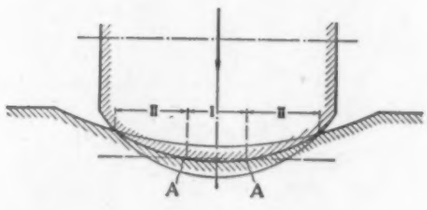
various instances throughout the industries, you can see how many people are going to have to yield in order to get standardization. The next thing you must have when you consider lubrication standardization, is a clear appreciation of the functions of a lubricant.

In bearings, we touch on the three phases that a lubricant should do. First of all, there is the readily appreciated fact that the lubricant is supposed to prevent metallic rubbing between two surfaces coming into contact with each other during rotation. There are several types of rolling friction. There is rolling friction that is a result of deformation between the contacts of the rolling elements and the races. No bearing has capacity unless there is deflection. A ball bearing has theoretical point contact until the load comes on and deflection develops area that provides load-carrying capacity as seen in Figure 1. With roller bearings you have line contact that develops into an area that is relatively greater for roller bearings than for ball bearings of comparable size.

Most roller bearings have flanges contacted by roller ends that must be lubricated, and there you have plain bearings. This rubbing creates more friction than in ball bearings with rolling contacts and only minor sliding in the raceways.

The contacts between cages and rolling elements vary. If the bearing is taking a radial load, only the

Figure 5 — Deformation occurs in an axial plane, at the contact point of the ball and the raceway.



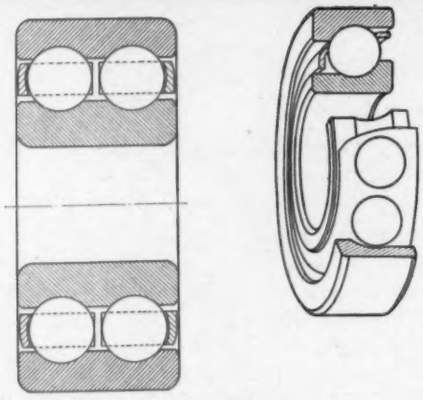


Figure 6 — (Left) Double row ball bearing without filling slots.

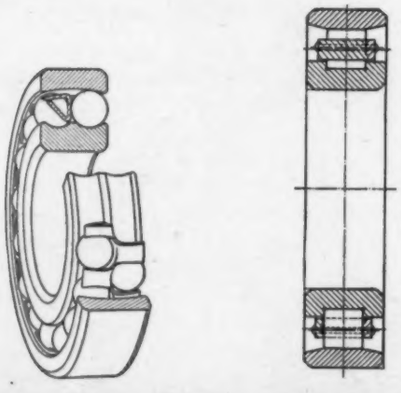
Figure 7 — (Right) Single row angular contact ball bearing.

rolling elements that lie in the direction of the load sustain the load and as these elements pass in and out of the load zone, they have a chance to relocate themselves with relation to the cage. When you have thrust and radial loads, if the thrust is high enough, all the rolling elements around the entire 360 degrees are under load to sustain that thrust, and you don't have that same opportunity for the rolling elements to relocate themselves with reference to the cage. Therefore, cage friction is higher in thrust than it is under radial load.

In addition to lubricating the bearing, you have to protect it. In certain steel mill applications, the grease helps supplement the seal, and that is a very important point. In certain applications, greases are chosen not only to lubricate the bearing but as to how effectively they will resist the washing of water and mill scale, or perhaps just dust in certain other applications. Thus lubricants supplement the seals and their more difficult

Figure 8 — (Left) The self-aligning ball bearing has good high speed characteristics.

Figure 9 — (Right) One of the first roller bearing designs is the single row, cylindrical roller bearing with roller riding cage.



function may not be to lubricate the bearings but to protect them.

Another application function of lubricants takes place at higher speeds where the path speeds are really rapid. Speed is a function of both rpm and pitch diameter. You may have 10,000 rpm with a small bearing of only ½ or ¾ in. bore and the resultant speed is not impressive; but, if you have a 4 in. shaft, 10,000 rpm is very high speed. In the latter case, the bearing has to be cooled, and that is another of the functions of lubrication, which supplements the functions of lubricating and protecting. The lubricant may have to handle well any one of these three functions or a combination of all three functions

In such a range of requirements, there comes the apparent fluid condition as to what lubricant to use and how one should lubricate. One must understand what the lubricant must do for a particular bearing application. Many times you get a condition wherein a special grease apparently solves a difficult problem. Well now, had that situation initially been thoroughly investigated, you probably wouldn't have needed anything special to solve that problem. You probably could have chosen a grease or oil, in advance, that would have done the job quite readily.

Therein comes the problem of standardization. Machinery manufacturers should have designers who realize the true conditions in the mill, in the shop, or wherever the machine may be located. A complication occurs every now and then when a machine is built for one speed and other technical conditions progress so as to permit a step-up in speed. Then, what was formerly a satisfactory design may require new consideration as to whether grease may have to be replaced by oil.

Whether you use grease or oil depends upon the type of bearing. Ball bearings as a rule can be lubricated at much higher speeds with grease than can roller bearing types because the former do not have flange contacts that are a limiting condition as regards lubrication. Then there are also rubbing contacts between cage and rolling elements and frequently also between cages and lands, lands in these instances refer to that portion of the races that support the cages. There are certain applications for which we make land riding cages and they may be required for a variety of technicalities. One of the most frequent reasons is an additional motion in which the whole bearing is also rotated about some other center, as for example a shaker screen. As a consequence a centrifugal force is developed that frequently requires a land-centered cage to adequately resist the tendency to displace the cage eccentrically. The bearing lubricant must also lubricate the contact between the cage and its supporting land.

The presence or absence of these many factors, with their variations, has to be considered when deciding what lubrication will be used in any particular bearing application.

The problem of standardizing the foregoing is a large one so that you can not criticize the lubricant manufacturer for not coming out with a catalog and saying that under these specific conditions, you can always use grease, and in others, you have to have a certain other lubricant. Until careful thinking is done generally,

any substantial degree of standardization progress is going to seem pretty well blocked.

The so-called Conrad bearing, shown in Figure 2, was patented during a period that might be described as the beginning of the modern bearing industry. The two races of a deep groove ball bearing do not have any filling slots in them, and the bearing is often as frequently identified by the name of the inventor, Robert Conrad, as by any other description. It is necessary to distinguish between it and the so-called maximum type shown in Figure 3, because in the maximum type filling notches in the races permit inserting more balls. The Conrad bearing is loaded with balls, as shown in Figure 4, before the cage is inserted by displacing one race until it touches the other, then the open area is filled with balls until a little over half the outer race ball path is filled. We actually deflect the outer race in order to snap in the last ball.

In the deep groove ball bearing of either the Conrad or the maximum type, there is a certain amount of rolling friction in the grooves, as well as some sliding friction. The latter occurs with a true radial load because area contact is developed at the no-load points. The developed areas extend circumferentially and axially, and under heavier loads the contact extends an appreciable distance up the sides of the ball groove as shown in Figure 5. Accordingly, the various points in the contact area in an axial plane will thus be located at different distances from the center of rotation and therefore minor sliding results because the angular velocity is a constant. There are also complicated phases of rolling friction as a result of deformation. Therefore the lubricant must take care of sliding friction and rolling friction as the result of ball contact with the raceways, and the rubbing friction between the cage and the balls which support it. This bearing has what we call a rolling element riding cage because the cage isn't supported by a surface that we previously called as a land. Any grease or oil that is on the balls is carried into their contacts with the raceways and the cage. Thus you can get by with a minimum of lubrication which may be grease or airborne oil. One can promote a flow of air with an oil mist through a bearing housing which will effectively wet all of the surfaces.

Figure 6 shows a double row ball bearing and it is quite similar to the single row just described. It shows instead of a so-called ribbon type cage of the single row bearing, a brass cage that gives a little better condition. There isn't too much difference between the attainment of effective lubrication for either a steel or a bronze cage. It is only under certain limited conditions that one can find any appreciable difference and I am stressing this because there is a popular conception that the bronze cage is much better than the steel. However, this feeling often goes back to a particular experience and not to a generally substantiated condition. Again in the double row bearing, there is need of lubrication between the balls and the cage and the ball contacts with the inner and outer races.

The single row angular contact bearing of Figure 7 is intended for applications where there is always thrust load, or principally a thrust load. It can carry radial load but it isn't desirable to do so because, fundamentally, it isn't economical and there are other

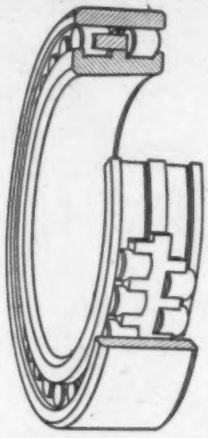


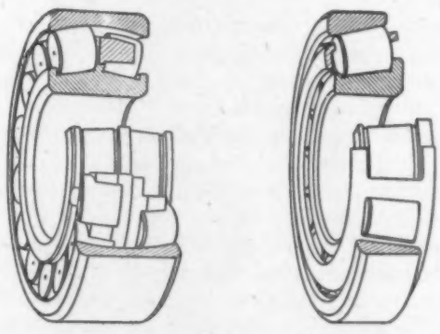
Figure 10 — The double row, tapered bore, cylindrical roller bearing with staggered rollers is used primarily in high speed machine tools.

design considerations. This bearing is so designed that the direction of the load through the balls forms an angle with the radial plane of the bearing. The thrust capacity increases with the contact angle because there is a larger component of the reaction that resists the axial forces tending to displace the race. The grooves in the races are made with one high and one low land or shoulder, so that they can be assembled with a large number of balls without the use of a filling slot. As a consequence they can absorb thrust in only one direction.

Because of the contact angle, they must be without axial play and so they are usually grouped in sets of two axially opposed to each other, or singly opposed to another thrust-carrying bearing. Under the influence of radial load in addition to thrust load, the balls travel in an elliptical path as the result of the radial displacement in the direction of the radial load. This results in different distances from the points of contact to the axis of rotation, and, with a constant angular velocity,

Figure 11 — Spherical roller bearing.

Figure 12 — Tapered roller bearing.



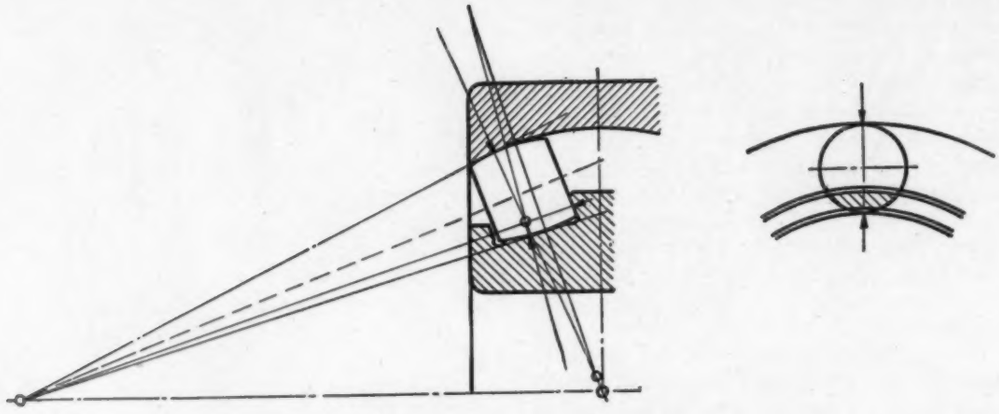


Figure 13 — Force diagram for the rollers of a spherical or tapered roller bearing.

the balls travel at different path speeds. Accordingly, there is a little bit more cage friction and this combined with the rolling friction gives a little more total friction than is present in a Conrad bearing if both were taking principally radial loads.

Figure 8 shows the self-aligning ball bearing which has very good high speed characteristics. The reason is perhaps obvious when one looks at the outer race. The inner ring with the ball complement can align itself freely around the bearing center and it is easy for lubricant in the housing to return to it, when it has been thrown from the bearing in the course of operation.

One frequently asked question is: "What is high speed," and over a period of time we have developed a rule of thumb relationship wherein we take a dimension in millimeters and multiply it by rpm. If you have a 60 mm bore bearing running at 2000 rpm, it is operating at a dn factor of 120,000; the letter "d" stands for the bore, and the letter "n" for rpm. This is just an arbitrary reference value that is most useful as we are thus in position to tell our customers in what range they use grease and beyond which it is normally desirable to resort to oil. The limiting value changes for the various types of bearings. It is also known that certain greases are better than others, and, if greases were standardized, we could identify the better one by number and not by manufacturer. This we would like very much as we don't want to take on the problem of selling grease.

The cylindrical roller bearings, illustrated in Figure 9, are the pioneer roller bearings. It is an obvious construction to begin with, and, as one might expect, it is also recognized as the roller bearing that can be run at the highest speed. It has no design force existing between the rollers and guide flanges. A guide flange keeps the rollers squared up so that the axis of rotation of each roller is parallel to the axis of rotation of the shaft. So long as this is true, there is very little tendency for the roller to skew, in which case flanges can easily keep them squared up, with the result that the nominal rubbing contact does not give increased friction due to skewing. As soon as there is definite skewing, the contact is changed and one obtains more friction, and the problem of lubrication is made more complicated. Also, when two convex cylindrical surfaces are not parallel, there is point contact. This skewing thus markedly reduces the capacity of the cylindrical roller bearing by reducing the no-load contact from a theoretical line to a theoretical point. Part of the technique of manufacture, through dimensional control, is to create an optimum clearance between the ends of the rollers and the flanges so that the rollers are kept square and yet permit lubrication. We therefore must compromise the desire to keep the rollers squared up for maximum capacity, with a minimum of guiding, and still provide space for lubricant between the ends of the rollers and the flanges.

Another type of cylindrical roller bearing shown in Figure 10 is one that is used principally for high speed machine tools. It has a very large bore for a given outside diameter and thus permits a spindle of large diameter, and consequent rigidity, in a limited space. The two rows of rollers are flange guided and staggered by the one-piece solid bronze cage. It is generally oil lubricated because of the high speed. When there is high speed rotation, there is an untiring tendency of centrifugal force to throw out and keep away any lubricant. Under these conditions, oil from grease returns to the bearing very slowly, and since the speed prevents grease from returning, you must have oil for lubrication in order to avoid trouble.

The spherical roller bearing is shown in Figure 11. There is another factor about this type of roller bearing and it is equally true of the tapered roller bearing, which is illustrated in Figure 12. When a load comes on these bearings, the force is transmitted by the inner race to the roller, and the rollers in turn transmit the load to the outer race. If a vector, shown in Figure 13, is used to represent the summation of the load at a point in the contact between inner race and roller and another

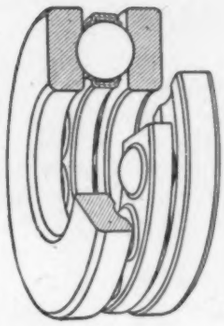


Figure 14 — This one direction ball thrust bearing's behavior is greatly influenced by centrifugal force.

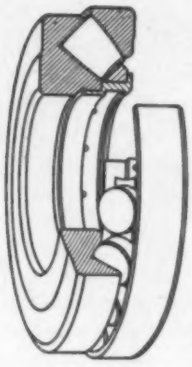


Figure 15 — The spherical roller thrust bearing shown is a new type.

between this same roller and outer race, tangents drawn to the roller at the two points will converge at a common apex lying along the axis of the shaft, and the tangent to a roller at an outer raceway contact is not parallel to a similar tangent to the same roller at the inner raceway contact roller. Since the included angle between the tangent to the outer raceway contact and the axis of rotation is greater than the similar angle for the inner raceway contact, there is a definite percentage of radial load pushing the large end of the roller against the guide flange, and this must always be the case since the radial components of the inner and outer race vectors are equal in order to have dynamic stability.

In the spherical roller bearing, there is a land-riding cage and in the tapered roller bearing there is generally a roller-riding cage similar to most ball bearings. A land-riding cage is relatively uncommon. One manufacturer makes his cage the land-riding type by putting pins through the centers of the rollers, and thus supports the cage on pins. The lubrication problem in this specific type becomes one of getting lubricant to the rubbing contact of the pins inside the rollers. In this particular tapered roller bearing construction, grease has greater difficulty getting to the critical areas, and therefore it is necessary to use oil lubrication at slower speeds than in the simpler ball bearing constructions. Furthermore, the greater friction of all these roller bearing features for a given load, in contrast to ball bearings, requires more lubricant in order to adequately serve the various rubbing cage and roller contacts.

Because of occasional smearing in the conventional ball thrust bearings shown in Figure 14, lubricant manufacturers may be accused of having supplied poor products because of this evidence in the bearing. However, at high speed, the behavior of this type of bearing is greatly influenced by centrifugal force. Most men have all played with gyro tops that hold their position with surprising stability; and remember how they resisted turning except about their own axis of rotation. There is a similar resistance from the rolling elements in ball bearings, and ball thrust bearings are the type most susceptible to this phenomenon. The balls rotate about their own axis readily enough but the sliding that develops the smeared streaks in the raceways is due to the gyral moment, resisting the change in the direction of the ball axes, as the axes are rotated about the shaft axis by the bearing rotation. To prevent sliding and cause the change in direction of the ball axes for a specific size, the ball load for a specific size is a function of speed and size, and increases directly as the square of the rpm and the first power of the pitch diameter of the ball path. Beyond a certain maximum speed for a respective ball size, it is impractical to use ball thrust bearings, because the magnitude of the preload to prevent smearing of the balls in the raceways results in too short a bearing life.

The spherical thrust bearing, shown in Figure 15, is a relatively new type with our company, and, as we are the manufacturer, it is really a new bearing. The flange of this thrust bearing covers more than half the diameter of the rollers, and in other words extends beyond the center. It is designed for oil lubrication, but we have used grease and obtained a measure of success. The basic design principle is the formation of an oil film, by the action of the roller, between the guide flange and the large end of the roller. A steel retaining ring is pressed into the relieved portion of the inner ring and is thereby centered. This ring has radial holes to permit centrifugal force to feed oil, from the groove in the inside diameter through the holes and so lubricate the land-riding cage and effectively supply the roller contacts with oil.

The various considerations that have been briefly discussed should be recognized, as they are involved, when a piece of machinery is designed. It is obvious that there must be an adequate appreciation by designers and draftsmen of the true factors. When adequate forethought is omitted and the machine has been shipped, it often becomes a job for the lubrication engineer to try to do something with an unpleasant set of conditions that should never have been permitted to exist in the first place.

Extreme Pressure Lubricants IN STEEL PLANTS

by C. R. HAND

▲ EXTREME pressure compounds, as the term is used today, consist of petroleum products, to which have been added metal or mineral solids. These solids are partially dissolved by the oils and mechanically mixed. The original lubricants used when pressures or sliding action was high, were petroleum products mixed with animal or vegetable oils. These were known as compounded oils. The various types, grades, and their merits, and demerits have been covered by many authorities in the last few years. It is the purpose of this discussion to segregate and qualify the facts regarding the need for extreme pressure compounds in some steel plant equipment, and also to show how useless extreme pressure compounds are in other steel plant equipment.

The first applications of extreme pressure compounds were in hypoid gears in heavy truck drives. This was after the compounded oils had failed to carry the heavy sliding loads imposed on the gear teeth. Steel plants have this type drive in their trucks and extreme pressure compounded lubricants must be used. There are a few hypoid gears used in other steel plant equipment. Where they are used, extreme pressure compounds are again necessary.

The next applications in steel mills have been on heavily loaded worm gears, particularly, mill screw downs on hot and cold strip mills. Extreme pressure compounds are necessary on these because of oversize motors and undersized gears and worms. Other worm gear drives used in steel plants have been lubricated for long periods with compounded oils. It has not been found necessary to change these over to extreme pressure compounds. The old style single wire drawing blocks is a case in particular.

Centralized LUBRICATION SYSTEMS

by WILLIAM M. STILWELL, JR.

▲ THE scope of this paper restricts itself to centralized lubrication systems of the "one shot" type, or the type of system which delivers a predetermined measured quantity of lubricant to a bearing at whatever time interval that bearing requires.

In 1917 or 1918, the initial step was taken in the development of centralized lubrication systems. The pressure gun and nipple were first used in automobile chassis lubrication. It was not until five years later that pressure guns were widely used in industrial plants.

The inability to lubricate machines while operating, by the pressure gun, lead to the development of the so-called multiple tube system. Tubing was run from bearings to a central point and connected to separate grease fittings. The pressure gun was used to force lubricant through the tubing to the bearings. The disadvantages and inadequacies of this method became apparent, when it still left to the human element the judgment of determining how much lubricant was forced into the lines. Furthermore, it was not too difficult for the greaser to miss points. A measuring nozzle was conceived but this was not flexible enough to compensate for the various sizes and types of bearings.

Then came the many and varied types of automatic feeding grease cups, which were generally spring actuated. Changes of temperature, the separation of the oil from the soap in the grease due to the maintenance of pressure on the grease, handicapped the performance of the automatic grease cups and limited them to use on specific applications. However, they are used successfully today for special applications where normally variable factors can be controlled.

Over twenty years ago the mechanical oil lubricators were developed. They today have their field of application.

It is important to mention here that no one lubrication device is a "cure-all." No single lubrication system

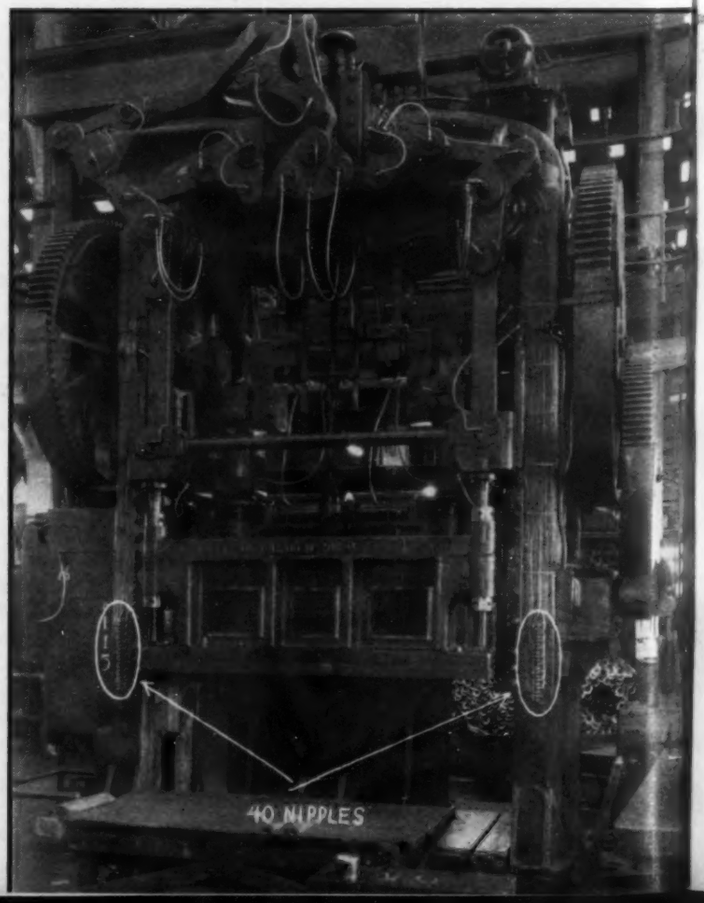


Figure 1 — The toggle press illustrated is an example of a machine requiring adequate lubrication. Each bearing is served by an individual line lubricated from a panel

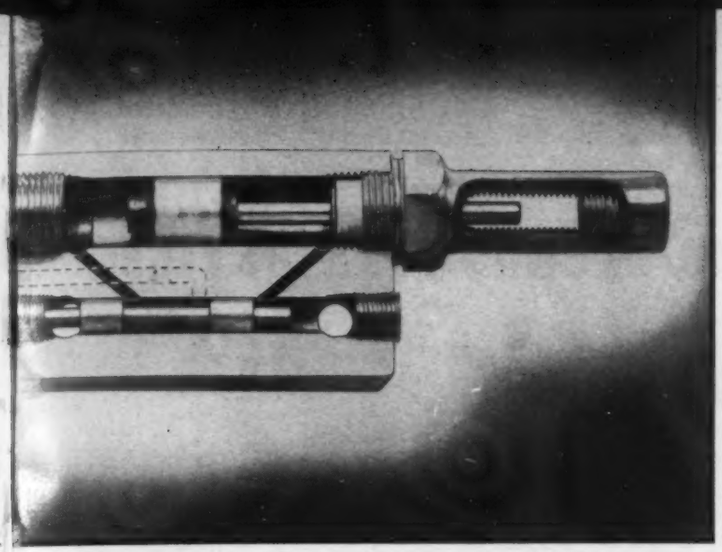


Figure 2 — The measuring valve is the heart of the modern, centralized, lubrication system.

is best for all types of lubricants and all types of machine equipment.

The limitations and disadvantages of all these early methods of lubrication emphasized the need for the positive delivery of high quality, clean grease of predetermined volume at the required intervals, regardless of the condition of the bearing. Furthermore, this delivery must be made independently of all other bearings in the system.

Thus we should remember that the basic features of a modern centralized lubrication system should be threefold:

1. It should be capable of distributing any type of grease or oil which can be pumped through the supply lines.
2. It should provide for a wide adjustment of quantity of lubricant delivered to each bearing, since the amount a bearing requires is affected by shaft speeds, conditions of operation, and length of time the bearing has been in service.
3. It should have tell-tale indicators to show successful operation of valves and to locate difficulties quickly.

The heart of the modern centralized lubrication system today is the measuring valve. Regardless of the type of system, there must be a measuring valve at each point of lubrication. A typical one is illustrated in Figure 2. There are two moving parts, which are hydraulically operated. In principle, it resembles the Corliss slide valve which was mechanically operated. There are no springs, check valves or restricted ports or orifices.

Three methods of employing such a measuring valve to lubricate equipment are available. The selection of one of the three methods is determined from an analysis of the lubrication problem.

One method is used with isolated or small number of bearings where the cost of a complete system would be prohibitive. Several measuring valves are assembled in a block so that a greaser can use a portable gun to operate the system. Discharge ports from the valve block are connected to bearings in the conventional way. The amount of lubricant going to the bearings is accurately measured and this device removes from the oiler the guesswork of how much lubricant is going to the bearing. Such a system is illustrated in Figure 3.

Another method is a manual centralized system involving a hand operated grease pump, permanently piped in the system. This makes a self contained system, requires only that an operator pump the grease compressor by hand. The frequency of lubrication determines whether a manual system is recommended.

A third method is a full automatic system. An automatic central station, motor driven or driven from the machine to be lubricated, timed either electrically or hydraulically, is likewise permanently piped to the measuring valves whose discharge ports are piped to the bearings. Such a system is selected because of the frequency of lubrication required or because dependable operation of the manual pump is not available.

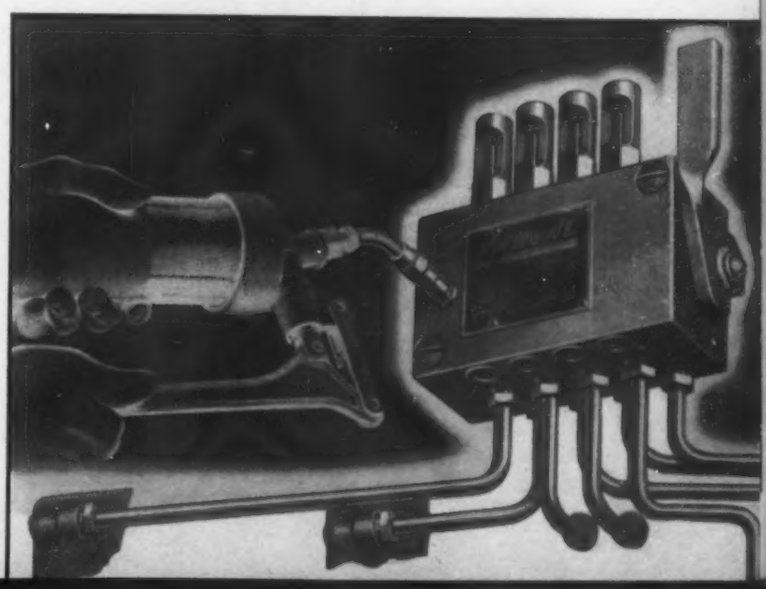
Regardless of whether the system employed is the individual valve block type, manual or automatic, the use of quality grease properly applied through a modern centralized system of lubrication will:

1. Save lubricant.
2. Reduce power consumption.
3. Increase bearing life.
4. Reduce labor of oiling.
5. Reduce repairs and maintenance.
6. Prolong life of equipment.
7. Eliminate potential lost time accidents.

Cooperation on the part of the ultimate user should involve careful consideration of:

1. The selection of the proper bearing materials.
2. The provision for sufficient bearing area to support the load.
3. The correct grooves in the bearings to insure proper distribution of the lubricant.
4. The protection with adequate seals where necessary.
5. The selection of the proper kind and quality of lubricant for the bearing design and operating conditions.
6. The provision for a dependable means for the proper application of the right kind of lubricant at regular intervals.

Figure 3 — This device is used to lubricate several bearings at one time.



A Sixty-Ton Slab TURN-OVER DEVICE

. . . . the slab turn-over mechanism described in this paper is a unique mechanism which solved a difficult problem in the world's largest plate mill . . . .

by Walter H. Burr

ELECTRICAL SUPERINTENDENT

LUKENS STEEL COMPANY

COATESVILLE, PENNSYLVANIA

▲ DURING World War I, Mr. Charles Lukens Huston, then vice president in charge of operations of Lukens Steel Company, carried to a successful completion, the installation of a 206 in. 4-high plate mill. It was then, and still is, the world's largest plate mill. Naturally, some unusual problems were encountered, first of which was that of turning the ingots, some of which weighed 90,000 lbs, so that they could be rolled to width and cornered when necessary to produce the best quality plate. This was overcome by using tapered rollers on the approach table, by driving the first, third and fifth rolls with one motor and second, fourth and sixth rolls with a second motor. To turn the ingot, simply run one motor in one direction and the second motor in the opposite direction.

The second problem was that of turning the ingot over so that both sides could be thoroughly cleaned while rolling. This second problem was not solved successfully until World War II. For a period of about ten years, prior to the installation of our new 60 ton turn-over device, we had used an enclosed rack which consisted of two large links cut out of heavy plates, and assembled so that they could be handled with a 75 ton crane which is over the mill. These links were designed so they could be lowered between the table rollers. The slab after leaving the mill on the table rollers entered the links. With one end of the rack attached to the crane hook, and the other resting against the table, the crane lifted the rack and slab to the vertical position, crossed the table, lowered the rack against the opposite side of the table, and continued to lower the rack with the links in position between the rolls. The tables were operated and the slab returned to the mill. Figure 1 shows the construction of this mechanism.

Obviously this method was crude and cumbersome, and when the need for armor plate in great quantities became urgent, some better method was considered necessary. The problem was one that involved principles similar to those encountered in crane design, so a representative of one of the leading crane builders was asked to consider this problem. This turn-over device is the result.

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The details of this device are shown in Figure 2. A short runway is provided directly over the approach table. On this runway is located a trolley driven by a 10 hp series wound motor which travels at right angles to the direction of travel of the mill tables. On this trolley is a heavy frame work, on each corner of which is a rack, each driven by a pinion, with all pinions driven by one 200 hp series wound d-c motor. On this framework is located the turn-over mechanism which consists of a main shaft driven by a 65 hp compound wound d-c motor, and on this shaft are located three elongated castings or drums to which are fastened three large slings. Each of these slings consists of a section of heavy link chains, a casting of suitable dimensions to fit in the table between the rolls, a short section of link chain, a second casting similar to that just described and another section of heavy link chain. The two ends of each chain are fastened to the same point on the drum. In effect, there are three drums driven from the same shaft and operating three separate slings. The spacing of these slings is such that they will handle the longest and shortest slabs rolled on the 206 in. mill.

The operation is as follows. The hoist is lowered so that one set of castings is in position between the table rollers. The tables are operated placing the slab in position in the slings. The frame is raised by means of the racks and pinions to a height sufficient to permit the turning of the slab as shown in Figure 3. The drums with their major axes in the horizontal position are rotated, pass through the vertical position and come to rest with the major axis again in the horizontal position. By lowering the hoist, the second set of castings in the slings are placed in position between the table rollers. When the tables are operated, the slab can be sent back to the mill for further reduction.

The device is controlled by the table operator and can be operated automatically or manually. It not only turns over these slabs, but it serves another very useful purpose to speed up operations. When it is necessary to send a slab back to the heating section for any reason, the operator places the partly rolled slab in the device, lifts it out of the road of the next ingot to be

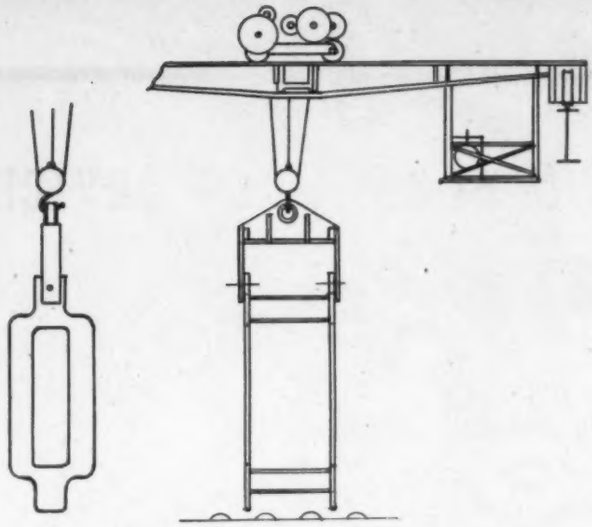


Figure 1 — The original slab turn-over mechanism was crude and cumbersome for present requirements.

Figure 3 — As slab is picked up, it is first turned into a vertical position.

rolled, as shown in Figure 4, and after it passes, lowers it on the table and sends the slab back to the heating section. The time cycle of this operation can be adjusted within certain limits, but we have found from experience that it is not advisable to carry out this operation too rapidly with a 110,000 lb ingot. This time cycle varies with the weight of the slab and in general requires from approximately 1.25 to 2 minutes. The problem of the overhauling load was not an easy one and counterweights were used to reduce the load on the driving mechanism while the slab is being turned over.

A general description of the device is as follows:

Overall width of machine	23 ft- 0¾ in.
Overall length of machine	25 ft- 6 in.
Total possible lift	6 ft- 6 in.
Center to center of slings	11 ft-10 in.
Trolley span	13 ft- 9 in.
Trolley travel	8 ft- 0 in.
Hoist speed	226 fpm
Trolley speed	39 fpm
Turn-over speed	1.3 rpm
Counter balance weights	Six — Total 24,300 lb
Maximum wheel load per wheel	72,500 lb

A time check on a 58,000 lb slab showed the following:

	Min
Lower into position	0.48
Hoist	0.30
Turn-over	0.50
Lower	0.44
Trolley into position	0.05
Hoist out of way	0.26
Total time	2.03

So after a period of some 25 years by the use of this device, we have solved the second major problem encountered in connection with the rolling of 110,000 lb ingots in the world's largest plate mill.

Figure 2 — Sixty ton slab turn-over device assembled prior to shipment to the Lukens plant.

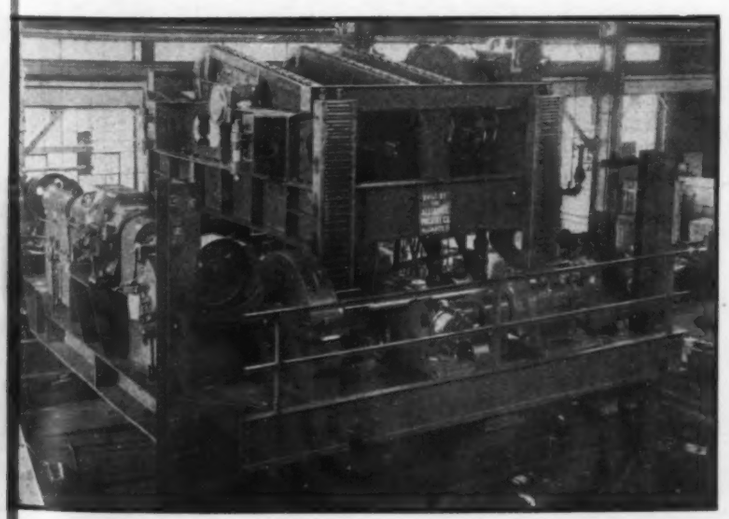
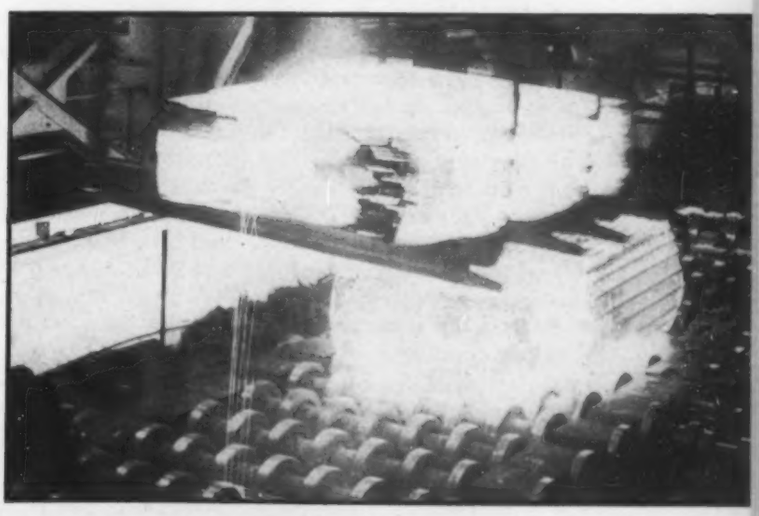


Figure 4 — The slab turn-over device allows one slab to be lifted out of the way, while another passes on the approval table.



LUKENS TELESCOPIC STIFF-LEG

Soaking Pit Crane

. . . . the telescopic stiff-leg soaking pit crane can be used where limited head room and light runways do not permit the use of a conventional stiff leg crane . . . .

by John S. Morris

PROJECT ENGINEER

LUKENS STEEL COMPANY

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▲ In 1945 Lukens Steel Company celebrated its one hundred and thirty-fifth year of pioneering in the steel industry by being the first company to install an entirely new design of soaking pit crane. The design and operation of this crane are so novel that many steel plant operators have come to Coatesville to see it in use.

The 140 in. mill, its soaking pits, and buildings, were first installed in the summer of 1903. Since that time, the soaking pits have been re-designed several times to keep pace with modern heating practice. The soaking pit building, however, has remained as originally designed, the lower chord of the roof truss being only high enough for normal clearance for the trolley of a 10-ton mill type crane. The accepted method of charging and drawing ingots at that time was with the use of standard mill cranes and tongs.

After the installation of the new 120 in. mill soaking pits with the attendant standard stiff leg cranes which gave greater ease in handling ingots, the operating and electrical departments began to plan on all soaking pits being serviced with stiff leg cranes. The 140 in. mill pit cranes of course furnished a logical starting point for the realization of these plans.

At first it was thought that it would be impossible to install a stiff leg crane on the existing runway, since the runway was of light construction; and also because the crane clearances and head room were designed for a standard 10-ton mill crane. Preliminary investigations substantiated the fact that the standard high type stiff leg crane could not be used on account of the excessive head room required. It was also found that the standard low type stiff leg crane could not be used on account of the excessive weight, relatively high lift, and because of the type of slab ingots that had to be handled by this crane.

It was therefore necessary in order to meet the exacting conditions, to design a stiff leg soaking pit crane having the construction features to be described. A representative of a nationally known crane builder was called in for consultation and the problem of designing a special stiff leg crane was turned over to him, with gratifying results.

The completely new and unique design finally decided upon was one that was equipped with a hollow, rectangular, telescopic, revolving, self-lubricating, flexibly connected stiff leg. This crane is now known as a "telescopic stiff leg soaking pit crane."

Figure 1 is a view of the above described stiff leg with the tong housing in its highest position. The column had to be hollow to permit the cable, which opens and closes the tongs, to get to the tong mechanism. The column was made rectangular in order to deliver the torque to the tongs to revolve the ingot. It would have been possible to make this column circular in cross section and deliver the torque to the tongs by means of keys and key-ways, but the rectangular section was adopted because it eliminated possible trouble with burred keys and key-ways.

Figure 2 is a close up view of the column extended, showing the rectangular telescopic sections. The column is telescopic so that when the tongs are raised to their highest position, the least amount of head room is required for the crane. This rectangular telescopic column makes an ideal torque tube, and since these telescopic sections are brass bushed, and friction is reduced to a minimum.

It is essential that when the tongs are at the bottom of the pit, as would be the case when an ingot should fall over in the pit, that the lower sheave over which the hoisting cables function should be as high as possible to prevent injury to the hoisting ropes and to prevent excessive heat from burning out the lubricant in the sheave wheel bearings. In order to protect the sheave wheels and cables from direct heat a large diameter flared pipe is welded to the top of the tong housing.

The lower rectangular telescope is also welded to the

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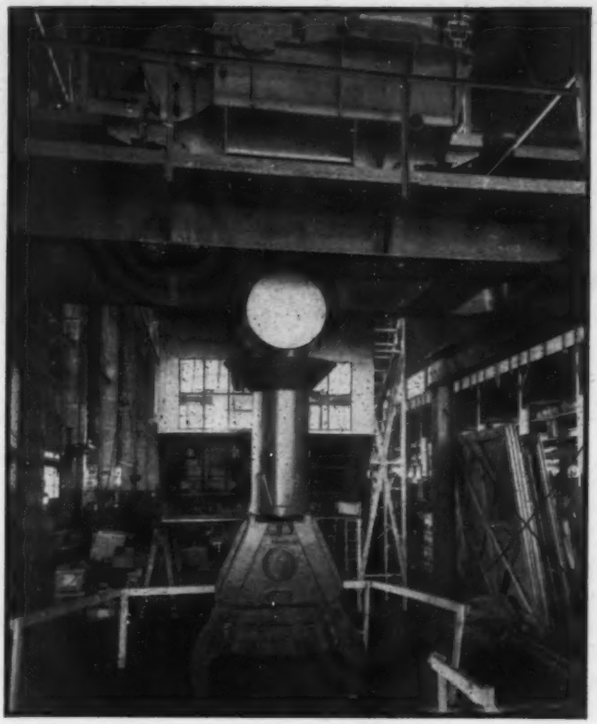


Figure 1 — The tong housing is in its highest position in this view of the telescopic stiff leg soaking pit crane. Trolley height is no greater than that of standard mill crane trolley.

Figure 2 — The column is here extended enough to show the rectangular telescopic section.

Figure 3 — Clearance diagram for telescopic stiff leg soaking pit crane.

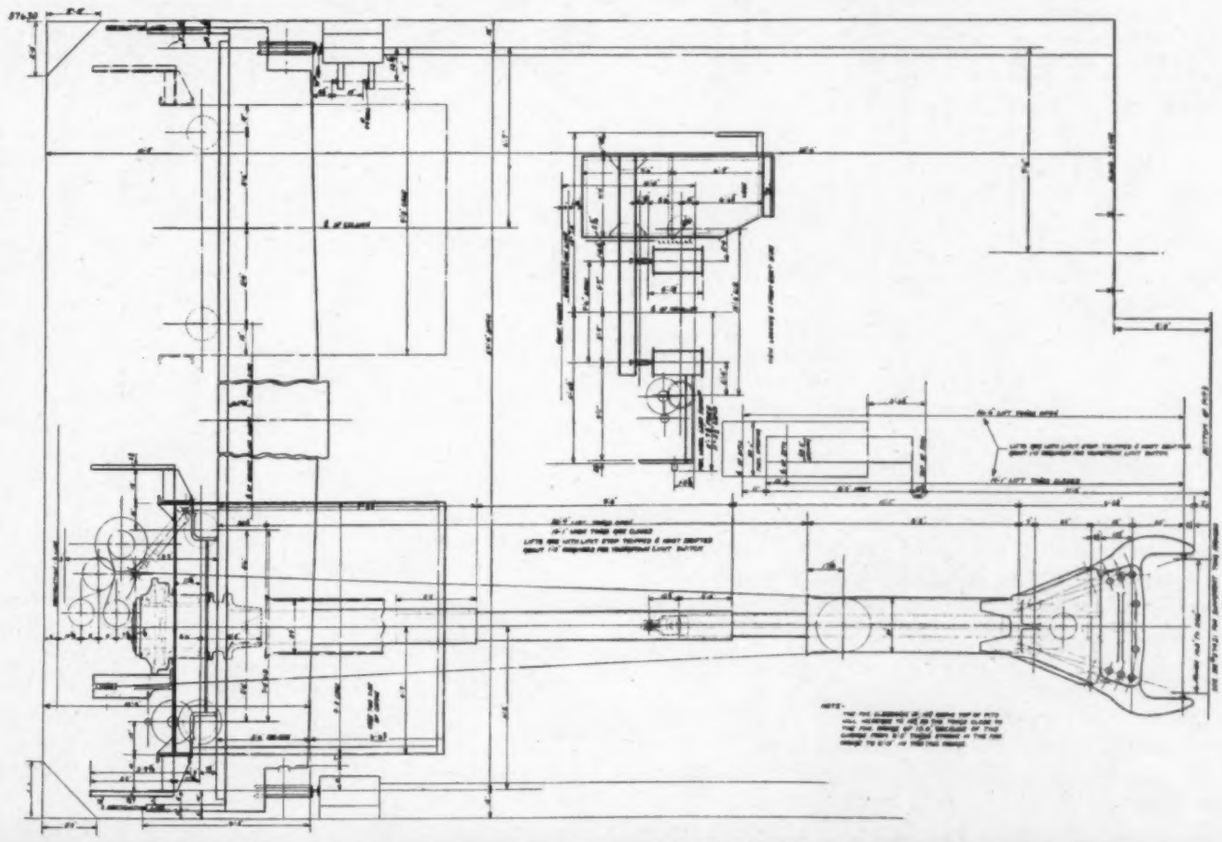


Figure 4 — This view of the top of the trolley emphasizes the compact layout.

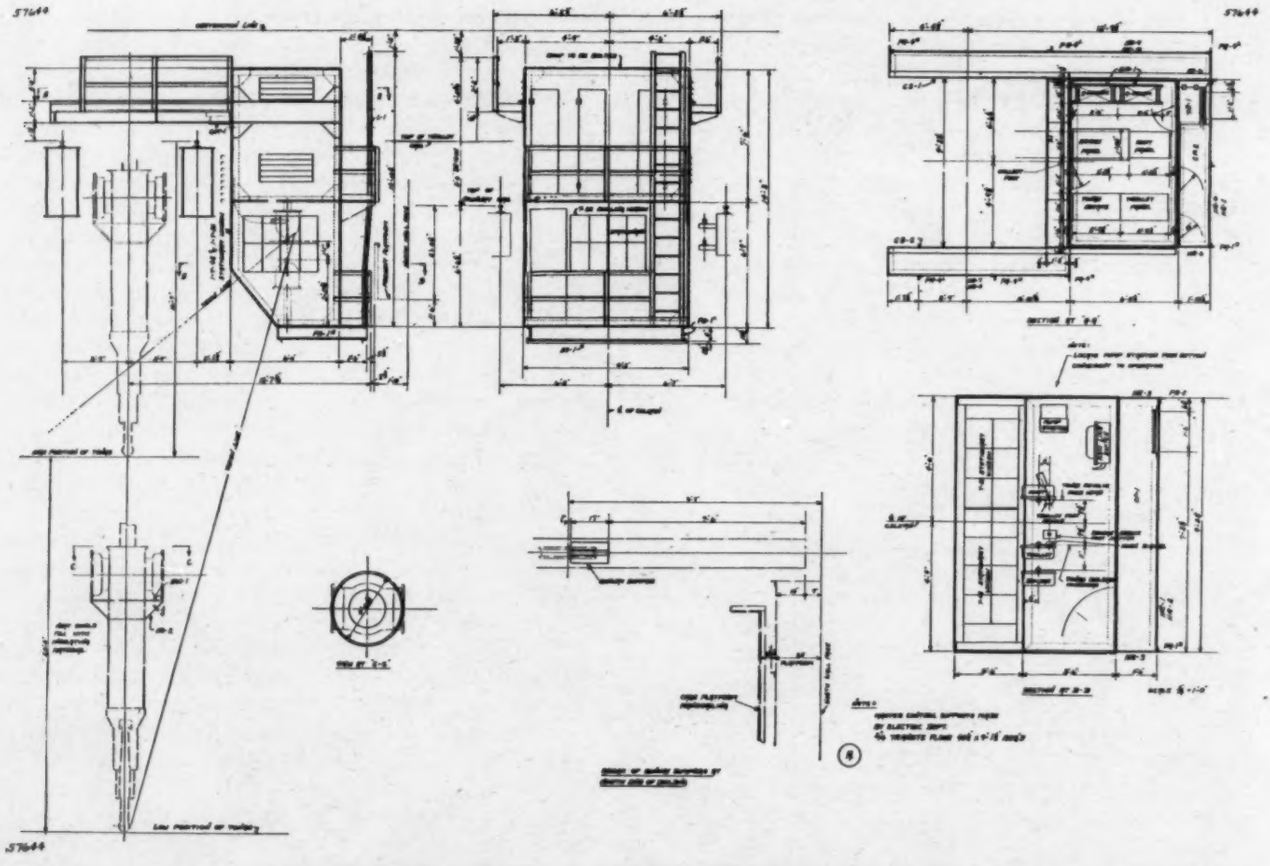
top of the tong housing and the space between the lower rectangular telescope and the pipe which supports the lower sheave wheel block provides an oil tight compartment or well. Since this compartment is filled with oil when the tongs are raised to their high position all of the telescopic sections are immersed in an oil bath. This provides an automatic lubricating feature which should result in low maintenance and efficient operation.

Figure 3, a clearance diagram, shows clearly the telescopic columns and the oil immersion reservoir referred to previously.

Since this crane was to be installed in a space designed for a standard 10-ton mill crane it was necessary to design a very compact tong operating mechanism in order to meet the existing clearance conditions. Near the top of Figure 3 may be seen the sheaves and hydraulic cylinder which actuate the tong opening and closing mechanism. The column revolving mechanism may also be seen in the center of the trolley. The height from the floor line to the runway rail is 30 ft, from runway rail to bottom chord of roof truss 10 ft, maximum lift of tongs is 20 ft 4 in., and the tongs are capable of reaching a point 3 ft 5 in. below the floor line when the telescope is extended.

Figure 4 is a view looking down on the top of the trolley. The two large drums carry the cables which raise and lower the telescopic stiff leg. The smaller center drums carry the cables for the tong operating mechanism. These cables may be seen in the center going down the hollow tube. In the lower right hand corner may be seen the hydraulic pump which furnishes power to the cylinder necessary to lift the sheave block

Figure 5 — The operator's cage is located on the trolley for maximum visibility.



operating the tongs. In the center is the gear reduction unit which rotates the telescopic stiff leg.

Attention is called to the fact that no load is supported by the hollow rectangular telescope. All of the weight is supported by the hoisting cables which in turn are supported on the heavy pipe member fastened to the top of the tong housing. The lower sheave wheel block, or crosshead, is equipped with upper and lower ball bearing races, and when the tongs are revolved there is no perceptible movement of the hoisting cables.

Another novel feature of this crane is the means of fastening the upper section of the telescopic column to the revolving mechanism situated on the trolley. Referring to Figure 1 again this feature may be seen. Instead of bolting the telescopic column solidly, the attachment is made by means of bolts equipped with springs. This was done to relieve the shock to the trolley and bridge mechanism in case of a collision when handling an ingot, or in the course of normal operation when the tongs might accidentally collide with some obstruction on the floor. This has proved to be a desirable feature and prevents many of the impact stresses which normally would result in breakdowns from reaching the trolley.

In order to afford the operator the maximum visibility the operator's cage is located on the trolley as shown in Figure 5. The cage supports are fastened to the trolley frame with the operator's cage on the outside of the follower crane girder. The operator is able to see all of the ingots in the soaking pit and at the same time his elevation is high enough so that an air conditioned cage is not necessary.

This telescopic soaking pit crane is equipped with a specially designed set of adjustable range tongs. The tongs may be adjusted to handle ingots as small as 10 in. and as wide as 60 in. This adjustment is made by inserting the removable pins in the holes desired. This adjustable range tong has the added feature of being very compact, requiring no more head room than is required for the standard soaking pit tong mechanism.

The crane furnished Lukens Steel Company was not designed with the intention of using it in making bottom in the pit, but it is possible to do so if care is used. The author understands, however, that all the newer cranes of this type will be designed with sufficient rigidity of the telescopic column to permit operators to make bottom; and it will be possible to exert a force of 5 to 10 tons at the bottom of the pit in rotation as well as longitudinally, and crosswise, without producing excessive stresses in the revolving mechanism or the telescopic column.

The Lukens operators are very pleased with the operation of this unique telescopic stiff leg crane and find it as efficient as the standard type stiff leg crane in general use throughout the steel industry.

DISCUSSION

PRESENTED BY

JAMES A. BELL, Assistant Chief Engineer, Bethlehem Steel Company, Bethlehem, Pennsylvania

L. F. COFFIN, Superintendent Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

C. A. TUNNER, Assistant Superintendent, Maintenance Department, Bethlehem Steel Company, Bethlehem, Pennsylvania

JOHN S. MORRIS, Project Engineer, Lukens Steel Company, Coatesville, Pennsylvania.

JOHN REED, Superintendent Electrical Department, Bethlehem Steel Company, Steelton, Pennsylvania

James A. Bell: Mr. Morris spoke about an oil well which lubricates the telescopic section. What means is used to retain lubrication in the upper section of the telescopic boom if the tongs are not lifted to the highest position at each operation?

L. F. Coffin: What is the lifting capacity?

C. A. Tunner: Assuming the telescopic type soaking pit crane does not make bottom, how do you make bottom and how do you free the slag from the bottom? Do you use a special or particular type of scraping device?

John S. Morris: As to the oil well lubrication, Mr. Bell suggested that if the tongs were not raised to the highest point after every operation lubrication wouldn't be satisfactory. That is true, but the tongs are raised, not after every lift, but frequently enough to keep the upper sections greased sufficiently.

To answer Mr. Coffin's question, this is a 10-ton crane and that is the maximum ingot weight handled by this crane. In answer to Mr. Tunner's question, at the present time, they do not make bottom on the pits at Lukens. The pit is periodically shut down and the slag dug out. Coke bottoms were used at one time but were discontinued prior to the installation of this crane.

John Reed: We have on order a 20-ton soaking pit crane of this general design. This crane will be much lighter than a stiff mast crane, for which reason it will be a four wheel crane in place of the conventional eight wheel crane.

Gear Ratios on Bridge Drives of Cranes . . . .

by H. H. Angel

ELECTRICAL DEPARTMENT

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▲ GENERALLY the actual bridging speeds are considerably in excess of the selected or crane manufacturer's rated speeds; as a result, some troubles develop in a few cranes. These may consist of high mechanical maintenance, motor overheating and slow acceleration. The following indicates corrective measures taken in a few cases.

Figure 1 shows a layout of the drives on two 20 ton soaking pit cranes equipped with roller bearing axles.

Two MD 416 BE2, 135 hp, 230 volt series wound motors connected in parallel are used with the maximum back-gear and track-wheel reductions. On the basis of full load, half-hour rated, motor rpm, the calculated speed was 211 fpm. Actual free-running no-load speed was 490 fpm. Since it was thought the speed resulting from connecting the motors in series would not be acceptable, a reduction to 365 fpm was obtained by inserting armature shunting resistors. This, of course, is a waste of power.

When another crane was required, the crane manufacturer was asked to furnish a higher gear ratio. This was accomplished by using double-reduction spur-gear boxes between the motors and line shafts. The calculated bridging speed, on the basis of 900 motor rpm, was 293 fpm. Actual speed was 377 fpm which was practically the same as for the other two cranes. Table I shows a comparison of the bridge speeds.

Figure 2 shows the layout of drives on two 7½ ton charging machines in No. 3 open hearth, each equipped with sleeve bearing axles.

Two MD 414 BE2, 100 hp, 230 volt series motors connected in series are used on each machine. The calculated speed was 296 fpm. The actual no-load speed is 500 fpm. It then drops to 389 fpm when pulling 30 tons of scrap buggies. This speed is thought a little higher than necessary. It has been necessary to apply motor-driven blowers to decrease the motor heating. The use of permanent resistance to reduce the speed has not reduced the motor trouble appreciably.

When another machine was required, it was ordered with a much higher gear reduction and motors were connected in parallel. Figure 3 shows the layout of the drives.

The calculated speed, based on 720 motor rpm, was 304 fpm. Actual no-load speed is 440 fpm. This drops to 388 fpm when pulling 30 tons of scrap buggies. Since twice the horsepower is now available, no motor trouble is evident. Table II shows a comparison of speeds.

Figure 4 shows the layout of drives on a 40/10 ton annealing-room crane in the 42 in. cold strip mill.

The calculated speed, based on the full-load speed of the No. 141, 100 hp, 230 volt, series-wound motor was 396 fpm. Actual free-running speed was 717 fpm. Since this crane handles a large amount of 10 ton coils, bridge motor heating was very pronounced, and it was necessary to use a blower. As the crane was designed for a high bridge speed, it was not necessary to use the maximum motor back-shaft reduction. This was then changed from 85/24 to 91/18. The actual speed is now 594 fpm.

Table III shows the tabulation of motor speeds, fpm, and approximate current readings before and after the change in gear ratios was made.

It is very evident that the motor currents, both accelerating and running, are considerably lower with the higher gear reduction.

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Figure 1 — Bridge drive layout on 20 ton soaking pit crane.

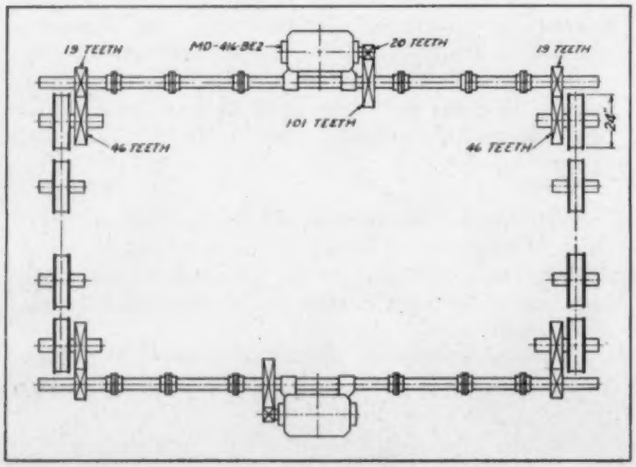


Figure 2 — Bridge drive layout on 7½ ton charging machine.

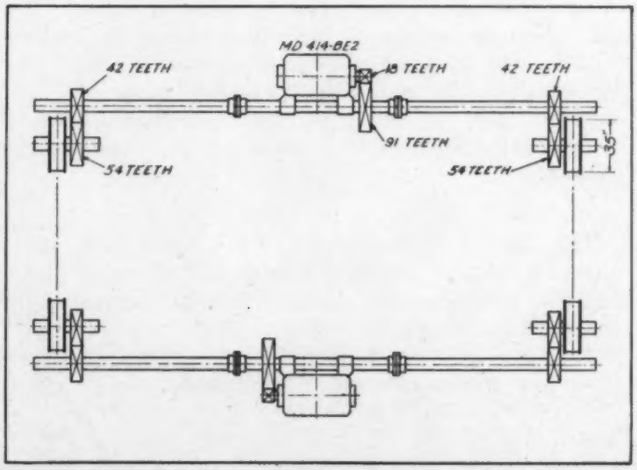


TABLE I

Crane No.	Calculated Bridge Speeds	Actual No-Load Speeds
No. 1 Soaking Pit Crane	$900 \times \frac{14}{46} \times \frac{14}{34} \times \frac{19}{46} \times \frac{24}{12} \times \pi = 293$ FPM	1150 × .326 = 376 FPM
No. 2 and 3 Soaking Pit Cranes	$410 \times \frac{20}{101} \times \frac{19}{46} \times \frac{24}{12} \times \pi = 211$ FPM	No. Perm. Res. 950 × .515 = 490 FPM 276 Ω Shunt Res. 710 × .515 = 365 FPM

TABLE II

Machine No.	Calculated Bridge Speeds	Actual Speeds
No. 1 Charging Machine—No. 3 O. H.	$720 \times \frac{18}{91} \times \frac{18}{36} \times \frac{30}{66} \times \frac{36}{12} \times \pi = 304$ FPM	No Load 1040 × .4237 = 440 FPM 60,000 lb Cars 915 × .4237 = 388 FPM
No. 2 and 3 Charging Machines	$\frac{420}{2} \times \frac{18}{91} \times \frac{42}{54} \times \frac{35}{12} \times \pi = 296$ FPM	No Load 355 × 1.41 = 500 FPM 60,000 lb Cars 275 × 1.41 = 389 FPM

TABLE III

Time in seconds after starting from rest	Old Back Shaft Reduction 85/24			New Back Shaft Reduction 91/18		
	Motor Amps	Motor RPM	Bridge FPM	Motor Amps	Motor RPM	Bridge FPM
5	310	300	283	330	350	231
10	350	...	...	170	...	...
15	210	600	566	140	730	483
20	160	...	...	130	...	...
25	160	...	...	120	...	...
28	160	690	651	100	850	561
33	160	770	717	100	900	594

Figure 3 — Revised bridge drive layout for charging machine shown in Figure 2.

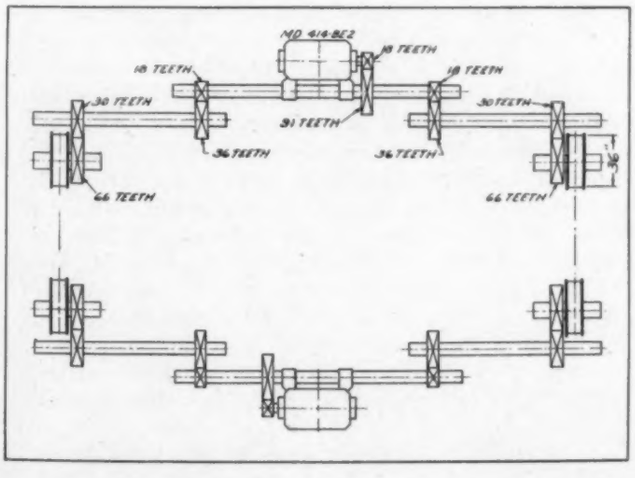
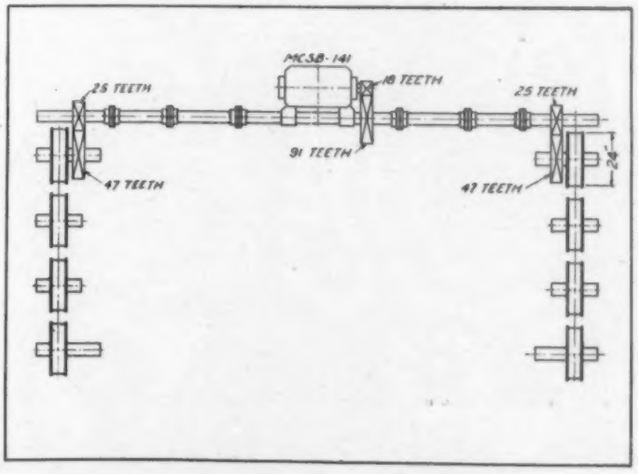


Figure 4 — Bridge drive layout on 40/10 ton annealing room crane.



A HIGH AMPERE CAPACITY SLIDING CHART

. . . . the principle of the mercury switch has been applied to transmitting high currents on sliding contacts . . . .

by M. B. Antrim

ELECTRICAL ENGINEER

LUKENS STEEL COMPANY

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▲ GREAT difficulty has always existed in transferring high currents of electricity from a stationary to a moving object. Up to the present time, machinery, requiring large currents, has had a definite limited length of motion for moving current carrying parts. There have also been additional space requirements for these parts because of the necessary use of heavy flexible leads, flexible copper laminations, or large numbers of carbon brushes. This situation has been especially true of certain types of welding machines.

All of the current carrying devices of this nature not only occupy considerable space, but also present their own peculiar difficulties, among which are resistance to motion, insulation wear, fatigue and contact difficulties experienced in using heavy leads and copper laminations, and also brush wear and burning when carbon brushes are applied. Also, due to the space required by these current carrying devices, considerable reactance is introduced in the high current circuit, acting to limit the current, and making it necessary to install a large amount of extra supply capacity of, in many cases, a special low reactance, to do nothing but supply losses in the circuit. As an example of this effect, calculations show the percentage reactance in the high current welding circuit of a certain machine to be approximately 30 per cent, or about twice the total percentage reactance in the entire supply circuit. All of this increased reactance in this case is due to the geographical configuration of the high current circuit.

To aid these conditions, a high current capacity sliding contact has been developed which does not limit or produce any resistance to motion and will not wear. Due to the comparatively small size of this contact, it may be so placed in the electrical circuit to introduce very little reactance.

This contact consists of parts as illustrated in Figure 1. A copper container holds a bath of mercury in which is suspended, in such a manner to always be separated from the container, an upper copper contact. There is sufficient mercury in the bath to completely cover the contact surface of the upper contact. Either the container or the upper contact or both may move, motion between them causing both contacts to slide on a film of mercury which for practical reasons is kept at a minimum of $\frac{1}{8}$ in. thick.

Since mercury has approximately $55\frac{1}{2}$ times the resistance of copper, it is necessary to keep the length of the current path through the mercury as short as practical to avoid an excessive voltage drop across the contact and the production of large amounts of heat. The current path area through the mercury should be made as large as possible for the same reason. This accounts for the grooved and toothed interlocking surfaces of the contacts. It might be stated, that due to the raw machined copper surfaces of the contact and container, mercury amalgamation of these surfaces occurs. This effect is not harmful, and amalgamation

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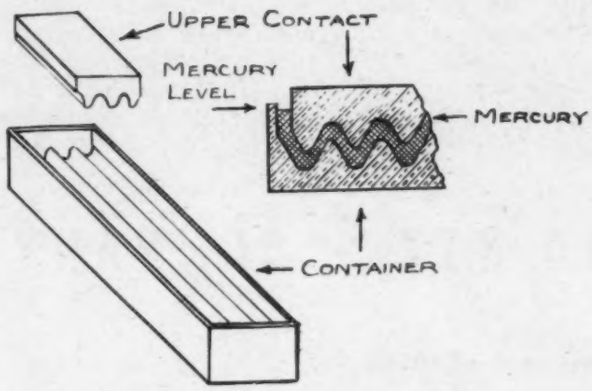

Figure 1 — Mercury acts as the sliding medium between the two contact surfaces.

ceases as soon as all the fresh surfaces have become amalgamated. The mercury bath is also self-cleaning, since only a few elements will sink to the bottom of the bath where they might get between the contact surfaces. The probability of any of these elements, in sufficient quantities to cause trouble, getting into the mercury bath is practically nil.

The formation of mercury oxide takes place on the surface of the bath; however this formation is very slow, and unless the quantity of oxide formed actually restricts the movement of the contact, or lowers the bath level below the top of the upper contact current carrying surfaces, it can be safely ignored. In any event, this mercury oxide can easily be removed from the bath surface.

Measurements have been made showing the temperature rise in this type of contact to be 15 F at a current density of 500 amperes per square inch per 1/64 in. length of current path through the mercury, and 24 F at a current density of 750 amperes per square inch under the same conditions. Both of these temperature rises took place during a 5 minute period of contact operation. For application on an intermittently operated machine, these temperature rises would not introduce any difficulty, and both the container and the upper contact may be water cooled with ease for application on continuously operated machines or where space is very limited so that the contact area must be decreased.

It is extremely important to place this type of contact in such a position in the high current circuit, that any magnetic field produced by the configuration of the circuit has its gradient horizontally disposed in order to eliminate motor action due to the passage of current through the mercury. Actually the small amount of motor action caused by the tilting of the current paths by the contact grooves is desirable, as any heat produced will then be quickly distributed for better conduction and radiation.

At present, four such contacts have been built and are in use on a flashwelding machine. These contacts have repeatedly carried 100,000 amperes each for periods of 8 to 10 minutes. There have been no signs of any trouble developing in any of these contacts.

The application of these mercury contacts is illustrated in Figure 2. The contacts are water-cooled as denoted by the hoses attached to the container. It is interesting to note that under operation no noticeable temperature rise has occurred in the mercury. A shield has been installed at the right hand end of the right hand contact to prevent welding scale and other objects from falling into the open end of the bath when the contact is near one end of its travel. A piece of woven glass cloth weighted at one end and hanging over a rounded edge at the left hand end of the contact protects the bath when the contact is at the other end of its travel. Due to the close proximity of the contact on the other side of the circuit, which may also be seen in this illustration, a projecting metal shield on this side of the contact would cause a short circuit. It may be noted that the right end of the container portion of the contact is removable allowing the spacing between the upper contact and the container to be easily checked during installation.

The maximum movement of the contact now installed is 13½ inches. However, this distance can be increased or decreased by changing the longitudinal dimensions of the stationary portion of the contact. The contact will carry a continuous current while moving over all or any part of its maximum travel. It is quite possible that properly designed and installed contacts of this type may be used in the future on a number of different types of machines requiring high currents for their operation.

Figure 2 — The sliding contact illustrated is water cooled.

Some New Devices

AT ALAN WOOD STEEL COMPANY

. . . . describing simple and effective schemes for weighing scrap buggies and for heating tar drums . . . .

by J. W. Deimler

ELECTRICAL ENGINEER

ALAN WOOD STEEL COMPANY

CONSHOHOCKEN, PENNSYLVANIA

▲ IN our open hearth department, we have a beam scale with an automatic printing attachment which is used to weigh buggies carrying scrap boxes. These boxes are used to charge other materials such as crushed dolomite and scrap into the open hearth furnaces.

It had been the practice for a good many years for the weighmaster to guess as accurately as possible when the scrap buggies were on the scale. At the same time, he would have to record, by means of an adding machine keyboard attached to the scale, the weight of each car identified by a number painted on the side. This system led to numerous inaccuracies. Sometimes the scrap car would not be completely on the scale when the operating button was pushed. Frequently, the number representing the tare for the buggy would be incorrectly recorded. As a result, inaccuracies in the amount of material charged into the furnace were always possible and often quite prevalent. In order to correct and prevent this condition, it was felt that an automatic device of some kind would be highly desirable.

The first step taken was to contact the manufacturer to determine what, if any, attachments were available for this application. His response to our inquiry was negative, and was accompanied by the suggestion that we buy a new scale. So we devised our own scheme.

The system operates in the following manner. The tracks consist of the usual two sets of rails over the scale. One set is rigidly supported, spanning the scale, and permits loads to travel over the same line without actuating the scale. The other set is attached to the scale platform in the usual manner and is free to move down with the scale beam when loading is applied. In this section, in one rail, the head and web of the rail were cut out in two places. These sections are about 4 inches long and spaced exactly on the centerline between the front and rear axle of the scrap cars. What had been the web of the rail at these cuts was then built up by welding bar sections along the rail web and thus providing a slot which was extended through the flange of the rail. A bar section was then welded to each piece of rail head and made long enough so that it extended down through the rail and beam and rested on the limit switch lever.

These switches are the spring return type and are mounted in the scale pit on the beam supporting structure. One switch is in the positive lead and the other is in the negative lead of the 230 volt d-c supply to the scale. Both switches have to be closed simultaneously in order to actuate the weight recording device.

As the cars pass over the rails, the electrical circuit is closed only at the instant that the front and rear truck wheels depress the two rail-head segments. The distance between front and rear axles is six feet, while the space between cars is approximately six and one half feet. Thus simultaneous closing of the switches occurs only when the car passes over the scale. When this circuit is closed, the actuating relay and timer of the scale printing mechanism are set into operation and the weight is recorded on the paper tape. As the car is approaching its center position on the scale, the weight man has ample time to record the number of each car on the keyboard attachment, The scale is actually adjusted for the weight of the standard car. If

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an odd size buggy is used, the number identifies it and the proper adjustment made.

This scheme has removed all guesswork from the weighing procedure and has resulted in a more accurate control of the material charged into the open hearth furnaces. The electrical circuit is the essence of simplicity and as long as the tracks over the scale are kept reasonably free of scrap there is practically no chance of failure.

In many magazine publications, one can see much advertising space devoted to many of the recent developments in electronic equipment, synthetic insulations for wire, plastics, types of lamps such as infrared, cold cathode, etc.

Probably you have wondered just how some of these products would be adaptable to the steel industry. Much publicity has been bestowed upon the infrared lamp and its remarkable contribution to speeding up such processes as drying in production line assemblies.

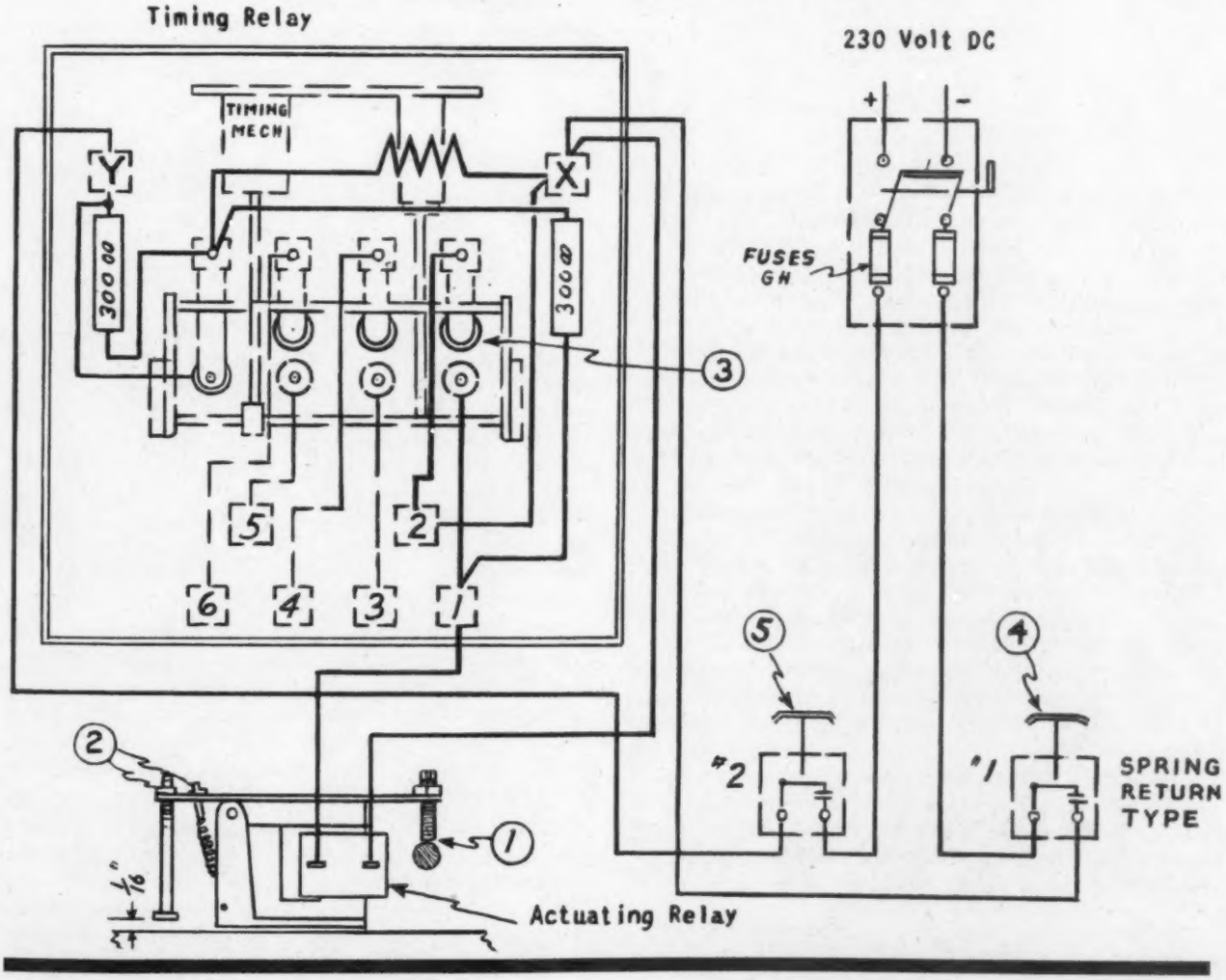
This lamp, applied as a source of heat, has been used quite satisfactorily in our open hearth department to heat drums of tar. This tar is the ordinary crude coal tar obtained from the coke plant and is used to spray the interior of ingot moulds to facilitate the removal of the mould after the ingots have been poured.

The equipment is relatively simple and consists of a sheet metal enclosure about $4\frac{1}{2} \times 4\frac{1}{2} \times 5\frac{1}{2}$ ft high, or large enough to accommodate the size of drum used. Four batteries of four-lamp units are placed in quadrature around the space occupied by the drum. The drum is moved into this enclosure on a hand truck on which it remains until ready for removal. The lights are so set that very little heat is directed on the truck. Two of these units provide us with ample quantities of heated tar during the coldest weather. Due to the nature of the heating effect which these lamps provide, insulation of the enclosure is not necessary.

The 16 lamps represent a power consumption of 4 kw and heat the tar to 150-160 F. Under the most severe cold weather conditions, the heating time is about a half-hour for a 55 gal drum.

Such a unit or group of units can be placed in the immediate vicinity of the area where ingot mould processing is done because it requires little space, offers no problem of power supply, and is free from the danger of fire or explosion. The installation provides a very economical, safe, and flexible system for obtaining the desired results.

Layout for automatic trip for printograph in open hearth scale house.



Maintenance of the Blast Furnace

COOLING SYSTEM

. . . . acid cleaning of encrusted pipe lines is finding an increasing number of applications . . . . a few steel plant applications are described in this paper . . . .

by G. Calder Little

ASSISTANT MASTER MECHANIC

BLAST FURNACE DEPARTMENT

BETHLEHEM STEEL COMPANY

SPARROWS POINT, MARYLAND

▲ PERHAPS many do not realize the importance of the cooling system in the modern blast furnace. This system serves two purposes; first it protects the brick lining by cooling, and second it holds the furnace lines after some of the brick have been worn away. A large furnace may have 480 copper blocks in the stack, 300 in the bosh and 75 cast-iron coolers in the hearth.

The cooling system of a blast furnace may vary from most systems found in industry in detail, but in general it is quite similar. Water is carried to the furnace in a cast iron main and distributed through manifolds to 1¼ in. pipe lines, connected to the cooling blocks. It is these small lines which cause our maintenance problems. Their failure or loss in efficiency is caused by galvanic corrosion and deposits of foreign materials in the pipes.

Galvanic corrosion is in itself a major problem which has gained considerable attention recently, particularly in the shipbuilding field. At Sparrows Point, we have found that this can be controlled with reasonable results, by making those parts which come in contact of the same metal, or by making the anode in the system larger than the cathode. For instance, a steel nipple in a copper block will not last a year, but a copper nipple in a copper block connected to the steel pipe behind it through a galvanized malleable elbow will last four times as long. In the first case the small steel nipple is anodic to the large copper block; in the second case the larger galvanized elbow is anodic to the smaller copper nipple.

Since galvanic corrosion does increase with a rise in temperature, one solution to this, as well as other difficulties, is to keep the pipes clean. The only circulating water available comes from the Chesapeake Bay and contains salt as well as other minerals. These are held in solution until the temperature reaches about 90 F, when they begin to drop out and adhere to the walls of the pipe lines. The flow is constantly decreased and the temperature goes still higher. With a rise in temperature, we get more corrosion, and so on. This deposit not only fills the pipes, but it also covers the inner surface of the cooling blocks, where it acts as an insulator. Many valuable hours have been spent in replacing these blocks after they have failed in service.

For years our only method of cleaning this system was by blowing each set of blocks with air or steam, and flushing them with high-pressure water. This method at its best accomplished but little; all we could hope for was to remove part of the loose material. The portion which had rusted solid remained until the pipe itself was removed.

It was not until August 6, 1945, that real progress was made in removing this foreign material from the lines and also from the cooling blocks. On that day our "G" furnace received its first bath of hydrochloric acid. This acid was delivered to the site in trucks, was diluted to the proper concentration and pumped into

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the system. Since this furnace was in operation, the method used was somewhat different than on a cold job. One set of blocks was filled at a time with a ten per cent acid to which an inhibitor had been added. After acid appeared at the discharge, the supply cock was closed and the temperature in the blocks allowed to rise to a maximum of 179 F. Water was then turned in to flush out the acid. This process was repeated several times until a desirable flow was obtained. In some cases one soaking was sufficient, in others, three or four were necessary.

While the work was in progress, all operations were under the strict observation of capable chemists. The ingoing acid and the discharge were checked constantly. Temperatures at the blocks were taken, and occasional barrel tests were made as a final check. It was found that ten per cent acid going in would drop to four per cent on the discharge. The time required for each set of blocks varies greatly. Those in the bosh would not stand more than three or four minutes, while the hearth and part of the stack would require thirty minutes to attain the desired temperature. If the increase of flow can be taken as a measure of the results, this method is surely successful. The figures given below were taken before and after cleaning and the time is that required to fill a fifty-gallon barrel:

It will be noted that the flow was increased three or four times in the stack and six times in the hearth, with a considerable temperature drop in both. These readings were taken from furnaces which use water from the turbo-condensers. In the summer time this water comes to the furnace with a temperature of about 100 F.

On "C" furnace, which takes water directly from the river, the stack check showed an average of 2 min 14 sec to fill a fifty-gallon barrel (84 F) before treating, and 2 min 10 sec (84 F) after treatment. In the hearth, the time was cut from 10 min 30 sec (140 F) before treatment to 3 min 35 sec (108 F) after treatment.

The time required to clean this furnace was one third that of "B" furnace which had been in blast the same length of time but had been cooled with water from the condensers. Obviously our principal difficulty is high temperature water, but even with cold water our piping needs occasional cleaning.

The object of all blast furnace maintenance men is to have the furnace equipment last a full campaign. Since our modern furnaces operate for six to eight years, we must expect much more of the piping than in the past. The only answer to this is proper design to eliminate corrosion, and occasional cleaning of the entire system.

STACK

Before		After	
Time, min-sec	Temp, F	Time, min-sec	Temp, F
8-14	118	2-45	102
8-15	118	2-37	101
6-36	108	3-8	100

HEARTH

24-50	146	4-15	107

DISCUSSION

PRESENTED BY

L. F. COFFIN, Superintendent Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland

JOHN WEIGHTMAN, Foreman, Lukens Steel Company, Coatesville, Pennsylvania

GEORGE R. WALTER, Chief Electrician, American Smelting and Refining Company, Baltimore, Maryland

G. C. LITTLE, Assistant Master Mechanic, Blast Furnace Department, Bethlehem Steel Company, Sparrows Point, Maryland

L. F. Coffin: It might interest you to know that using the same method described by Mr. Little, we have cleaned all of the heat exchange surfaces on all of our blast furnace gas fired blowing and power generating engines, all of the air compressors throughout the plant, some of the transformers and a considerable quantity of other heat exchange equipment.

John Weightman: What kind of acid is used?

George R. Walter: Do you also clean transformer copper and brass cooling coils? I understood you to say the solution is held in the coil several minutes and then discarded. It seems to me that acid might attack the coil and cause premature leaks.

G. C. Little: The type of acid which is used is determined by the company which furnishes the solvent. As far as the blast furnaces are concerned, it happens to be inhibited hydrochloric acid. The reason we threw the solvent away was because we found that by filling a system, shutting off the flow, and allowing it to stand in the blocks until the temperature had reached approximately 170 F, the concentration of the acid had dropped from 10 down to 4 per cent and therefore had no further value.

As far as other units are concerned, I understand that in many cases, the acid is recirculated but this is not done in a blast furnace. These blast furnaces were cleaned while they were in operation, and the heat from the furnace assisted in cleaning.

George R. Walter: My question was primarily in reference to transformer cooling coils. We circulate a solution of hydrochloric acid, concentrated 15 per cent by volume until it drops to 5 per cent as determined by titration. At this point, we restore concentration to 15 per cent and continue circulating. When the concentration stops falling, the solution is flushed out and the coil neutralized to remove all traces of acid. We found from visual inspection on a test sample, before and after cleaning, that this material and method do an excellent job with safety. These compounds are marketed under a trade name which I would be glad to pass on to anyone interested.

PORTABLE TOOLS SHORTCUT

Steel Mill Maintenance

. . . . when it has appeared necessary to remove an essential machine for repairs, portable tools can often step in the breach to effect on-the-spot needed repairs . . . .

by G. D. Muschlitz

ASSISTANT MASTER MECHANIC

MIDVALE COMPANY

PHILADELPHIA, PENNSYLVANIA

▲ We are laying no claims to originality in the frequent use of portable tools in our plant, but we feel that some of our applications may be of interest and value. As in all other steel plants, production time of our tools was at a premium for the past five years. Machine facings, bearings, etc., did wear, in spite of the production manager's distaste for shutdowns. Shortcuts, patches, quick repairs, were of necessity, "pulled out of our hats." Now that we can sit back and reminisce about the times when, entire presses, engines, pumps and hammers were rebuilt, literally in hours, when formerly any sensible engineer would have estimated days, we can analyze the methods which were employed.

Among our greatest time savers were portable tools, namely: boring bars, planers, and millers. Transportation, rigging and manhandling are at best an expensive and lengthy business. Our machine shops are production shops, so considerable red tape, haggling and threats are necessary to stop normal production and throw in a special repair job.

With these things in mind, as a repair turned up, we immediately thought in terms of, "What machine work can we do on the site?"

Naturally, the first question concerns accuracy. An answer can be obtained by citing a recent repair to a 1780 ton hydraulic press. The fits of the four columns in the bottom block had worn to such a point that one column actually broke. These holes are spaced at approximately eight foot and six foot centers. One of the peculiarities of this press is that its assembling requires the threading of the columns through the tophead and crosshead into the bottom block. The crosshead is bushed, consequently the holes in the bottom block had to be rebored exactly, and one-sixty-fourth inch tolerance was specified. A check after boring, facing, and installation of steel sleeves for column fit proved we were within this tolerance and a year and a half's work, twenty-four hours a day, on a forging and piercing job, proved the repair well worthwhile, and our fears of inaccuracy were dispersed.

In a second case, a 6000 ton tire forging press's main cylinder contains a counterbore approximately eleven inches long and one quarter inch deeper than the remainder of the cylinder for the retention of the stuffing box bushing. The lip of this counterbore had rounded and allowed the bushing to slip up into the cylinder, thus causing it to close in and make packing a very sloppy and short-lived job. We lowered the ram, inserted an eight inch boring bar into the cylinder, allowing it to protrude through the water inlet at the top of the cylinder, and proceeded to bore one-quarter inch from the diameter of the fifty-two inch cylinder. This, incidentally, was a treated chrome nickel forging and did not permit safe welding. Then we cleaned up with a light-finish cut and a new square lip for the stuffing-box bushing seat. A machine shop job of this particular repair would have involved the removal and re-erection, without crane service, of the 60 ton ram by cribbing, jacking and manhandling; next, the removal and re-erection of considerable piping, and finally, the removal and re-

(*Please turn to page 116*)

Presented before AISE Philadelphia District Section Meeting, April 6, 1946.

RECLAMATION OF PRECISION BABBITT BEARINGS BY THE GAS FLAME METHOD

. . . . the gas flame method has been found economical in rebabbitting precision bearings . . . . this article describes the required procedure . . . .

by R. A. McCarthy

ROD AND WIRE MILLS

BETHLEHEM STEEL COMPANY

SPARROWS POINT, MARYLAND

▲ TO the many and varied methods of babbitting can be added the torch flame method. This method simply makes use of an ordinary welding torch for both the tinning and babbitting operations. Manipulation of the puddle closely resembles the conventional brazing technique. Simple as it may sound, there were many preliminary problems to be overcome before the idea proved practical.

What are the possibilities of this method? What is wrong with pouring or casting centrifugally? How can distortion of the shell be avoided? These questions and many more had to be answered.

The original problem was presented by the performance of the bearings in the No. 2 rod mill at the Sparrows Point plant. These are high speed precision bearings in which a steel bushing is lined with a thin liner of cadmium babbitt bearing metal. Service was fairly good. Trouble actually started when bearing replacement costs were studied. The manufacturer reported that since the bearings had been cast centrifugally it was impossible to reline them and therefore they furnished new ones each time. With two-hundred forty bearings in the mill, it was obvious that replacement cost of bushings and thrust collars were going to be very high. It was agreed that something had to be done. It was also felt that the foundry pouring technique would cause the steel liner to distort too much. So it was suggested that a light welding torch be used so as to bond the metal to the steel shell thereby avoiding distortion by applying just enough heat to tin the surface. An attempt was made to build up on the old metal after a thin cut had been taken. This proved too difficult to handle with the torch. Every time a puddle was worked a dirty brown deposit rose to the surface to contaminate the metal. Investigation showed that this deposit was a compound of cadmium. On the next trial, all of the old babbitt was cut out and a fresh start was made with a tinning flux. The babbitt was applied after the tinning operation by means of the same light welding torch. The results were most gratifying. The tinning operation was very effective as long as some standard flux was used throughout. The oxygen-hydrogen flame used at first was later replaced by oxyacetylene without noticeable ill effects.

After tinning, the babbitt was applied by the same method used in bronze welding in which one bead at a time is made across the face of the bearing. Care is taken at all times so that the metal does not become overheated and boil. All fusion is at the surface. Care must also be taken to prevent the inner cone of the flame from penetrating deep into the surface of the metal. The hot zone of the flame is kept about an inch or so away from the surface.

The babbitt is cast in the form of rods, the diameter of which vary according to the thickness of the liners to be welded. Gas pressures and tip sizes vary likewise.

After each bead the bearing is turned slightly so that the adjacent bead is deposited in the horizontal position as are all the remainder until the whole bearing is done.

All oxides float to the top and are readily kept out

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of the interior of the melt by torch and rod manipulation. Upon completion of the bearing a hammer test will reveal an effective bond. It will be noticed after once getting a good bond and having a good babbitt metal that it is not necessary to do any more tinning unless the bond has come loose. The old metal can be built up on after a light cut has been taken. The shells are then bored out and placed in service. A complete record is kept on all bearings. Since September 1943, 170 bearings have been babbitted by the gas flame method and with the exception of a couple whose bond was poor, all are still in service.

By using the original shell with the cadmium bearing metal removed it was possible to do each bushing very economically. This has resulted in very substantial savings. Bearing life is better than on the original bearings purchased from the manufacturer.

Success at our plant stimulated trial elsewhere. For example, thrust rings for the same bearing have since been babbitted successfully. It should be borne in mind that savings are more easily realized where one pass of the torch will give the desired thickness. The rod mill bushings are 12 in. in diameter and have a babbitt lining of only $\frac{1}{8}$ in. thickness.

Further work has been done in this connection on hot strip mill back-up roll bearings. In this case, the original centrifugally cast babbitt is left in place and new babbitt is welded right on top of the old babbitt after a slight cut has been taken through the bearing. Evidently this does not disturb the bond underneath if done with caution as just described. Thickness of the babbitt is $\frac{5}{16}$ in. and rods of the same analysis babbitt are employed. No flux is used unless it is necessary to tin the shell. Since May 1944, fifteen large 30 in. back-up roll bearings have been reclaimed. None of these have failed and the savings are considerable.

On first consideration, the gas flame babbitting method might be overlooked because of the erroneous conception that it is too slow to compete economically with other methods. On the 30 in. backup roll bearings, just mentioned, it is possible to puddle 125 pounds of babbitt in five hours. This compares favorably with the conventional methods.

An additional factor that must be considered is the reduction of spare inventory that is possible when the complete reclaiming job is done right in your plant.

In April 1944, several connecting rods were installed on the air compressors of diesel engines, on the crankshaft bearings of a 1000 hp diesel locomotive, and on several main journal bearings also on a 1000 hp diesel. This method also has been applied in the boiler house. In July 1944, the thick poured babbitt on both the high and low pressure side of the air compressor connecting rods was replaced with a thin layer of babbitt which has eliminated the constant keying up on these bearings and the method has replaced two sets of main bearings on these compressors.

Since the gas flame method has been used, all applications have been successful. No doubt many other applications of this method can be made in which a saving in money and improvement in quality will result.

PORTABLE TOOLS SHORTCUT STEEL MILL MAINTENANCE...

(Continued from page 114)

erection of the 60 ton cylinder and transportation to and from the machine shops. A conservative estimate of the time required for this job would be twenty-one days. The actual time of our repairs was six days. This time included the necessary dismantling and re-erection, setting of the bar, etc., and was done with a considerable smaller crew than a machine shop job would have required.

In a third case, the columns of our 2500 ton hydraulic forging press are in reality cap bolts, twenty-three feet long, seventeen and one-quarter inches in diameter, and they are threaded three feet ten inches from the end with a head twenty-nine inches in diameter and fifteen inches in length. These columns or bolts fit through the head of the press and are screwed into the bottom block. On September 8th, 1943, considerable lift was noticed in the top head, and upon examination, it was found that the head of one column was broken off and a second was so badly cracked that it had to be removed by burning. After sixteen hours of attempting to unscrew the columns from the bottom block, we were convinced that it was impossible. Removing the two broken columns involved the complete dismantling of the press, with the likelihood of having to burn off the two undamaged columns, in order to drill out the portions in the bottom block. We decided to remove the broken heads of the columns to the machine shop and machine a counterbore seventeen and one-thirty second inches in diameter and drill seven holes three and three-quarter inches in diameter. A scaffold was erected and a portable milling machine was used to face off the tops of the broken columns for a fit with the counterbore of the heads. A five foot radial drill press was then installed on a piece of armor plate on a scaffold and seven holes were drilled and tapped into the top of each column. Alloy steel bolts, three and three-quarter inches in diameter, and two feet three inches in length with an elastic limit of more than 70,000 psi, were designed and machined and the existing split liners under the heads of the columns were faced to the proper thickness. The machined heads were then solidly bolted to the columns, and the repair was completed by September 19th, a total elapsed time of twelve days, including sixteen hours of time lost in attempting to remove the columns. If we had dismantled the press and had bored out four seventeen and one-quarter inch pieces from the block, and had had to manufacture four new columns, it would have involved an unthinkable shutdown of at least two months.

Time does not permit the description of innumerable other jobs which have been done in the past few years, such as boring out engine cylinders, patching cracks in bases, machining worn facings, etc., but our experience has proved beyond all doubt that portable tools should be a first consideration of any repair job.

Equipment Installation Helps

. . . . in an installation job, it is often the small details which cause the most trouble . . . . out of his many years of experience, the author gives many helpful hints to increase efficiency and reduce trouble on an installation job . . . .

by William A. Perry

ASSISTANT GENERAL SUPERINTENDENT

INLAND STEEL COMPANY

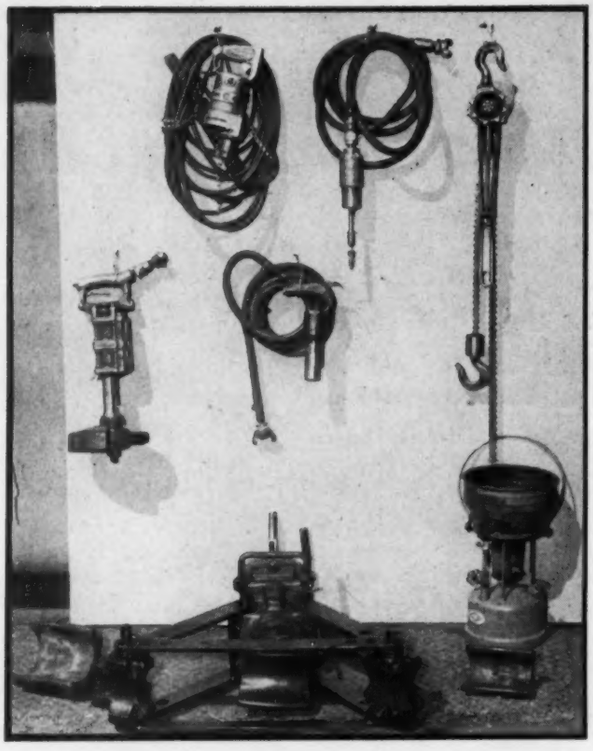
EAST CHICAGO, INDIANA

▲ THIS paper discusses the small things which are used on all jobs, not only new installations but also maintenance work. Quite often we use the same methods or devices for both, and then again they do not seem to go together. So if it appears that contradictory statements are made, it is because in one case it refers to a new installation and in the other case it refers to maintenance work.

One of the most pertinent points is to have the user of the equipment to be installed and the manufacturer of the equipment to be installed in perfect accord and agreement as to what is to be done and what is to be furnished. After that, the planning is relatively simple. The user tells us where the units are to be located, the manufacturer furnishes a complete list of parts and related blueprints indicating its part in the installation, and we proceed to tie the two together on the site. It sounds simple to express it this way, but it does require a few conferences between the manufacturer who will furnish the equipment, the department representatives who will decide the location of the equipment, and our installation lay-out men who will do the actual work. Having and using standards for line switches, motor starters, resistance lay-outs, control boards, master controllers, motor sizes, junction boxes, conduit sizes, wiring troughs, trolley bars and collector shoes, main field rails and collector shoes, line hardware and cross arms, just to mention a few items has enabled the lay-out and installation crews to speed up their work. This is possible because standard prints are furnished by the lay-out man when be supplies the location prints; therefore, he has less work to do on the lay-out for each individual job and the installation man receives many duplicate prints for each job and thus becomes better

Portable telephones are used to identify wires before marking.

Presented before AISE Chicago District Section Meeting, January 8, 1946.



Essential tools in an installation job are illustrated above.

able to plan the job more easily. We then receive the preliminary location prints and proceed to lay-out our conduit runs and make wiring schematics. From these, the wire foreman and his crew are able to install the correct number and sizes of conduits and pull in the correct number and sizes of conductors. We generally play on the safe side by installing just a little more than the actual lay-out calls for; because changes in almost any manufacturing or processing art are now very rapid and, generally speaking, when improvements or changes are made in the art, it requires additional motors or control devices.

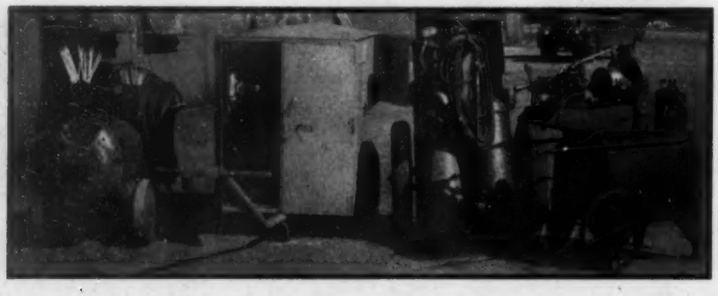
The purchase of equipment from prepared specifications enables us to work on many new installations with a minimum number of lay-outs. Factory fabricated and wired equipment is a decided advantage during installation periods. We endeavor to have the manufacturer properly label all equipment furnished us with the predetermined conformation furnished him at the time the order is placed. This enables the installation crew to rapidly locate and install the proper equipment. Endeavoring to install as much duplicate equipment as possible is also a great assistance. The foreman of the department in which the equipment is to be installed is called in to conference, and that department's replacement part list is used when specifying additional equipment. This also enables the foreman to be thoroughly familiar with the new installation and jobs coming up in his department, and gives him an opportunity to be prepared with replacement units when the equipment is ready for operation.

Having the plans on paper, it is usually an easy job to convince the operating and maintenance supervisors that we have made a proper lay-out. If they are not in accord, it is a relatively simple matter to make changes that will conform to their ideas if they are sound. This reduces the necessity of making changes after the installation has been completed. This method also makes possible the pre-fabrication of many parts in shops apart from the site where they are to be installed thus taking advantage of modern shop equipment during fabrication, and preventing the cluttering up of the site and perhaps making the operating man's duty more difficult. If heavy foundation work is required, it also enables the field man to include the proper supports, inserts and openings in the form work so that chipping of concrete is reduced to a minimum.

A study is made of the job and necessary equipment is on the site well in advance of the time when it will be needed. Here again standardization has been a big help. We have kept track of the materials most commonly used and have determined which can be most advantageously purchased from outside sources or manufactured in our own shops. Whichever indicates the best method, that is the one employed. Cross arms, line hardware, pipe clamps, eye bolts, U-clamps, and many other like articles are kept in stock and supplied as needed instead of taking out time to form them on the job. The crews doing the construction or installation work are supplied with portable buggies for their tools and supplies. They are so designed that they may very easily be moved about the plant from job to job. This is of great importance if the crews are called to a repair job with all their equipment and tools.

The careful selection of a sufficient number of the most useful tools and their accessories on the job is of material assistance in assisting the installation crew. We have a portable type threading machine which eliminates the necessity of hand cutting and threading. These machines are also furnished with bolt threading dies and alterations to standard or the making of special bolts is accomplished very easily and quickly. Conduit is bent with the usual hand type benders for the smaller sizes and hydraulic benders are furnished and used for larger-sized conduits. Of course, no job could be installed without the ever present burning and welding equipment using the oxygen-acetylene as well as electrical welding units. Small pull lifts are also provided to assist the men in handling heavy objects. The one-half ton size is very easily handled and almost

Welding and cutting equipment, as well as threading machines, are most useful tools in installation work.



indispensable on the job. For line work, motor operated winches are used and this speeds up the work due to the ease in locating winches at points of advantages of direct pull. Belt and disc type sanders and buffers are used quite extensively to lighten the construction man's work and speed up the preparation of parts formerly sanded and cleaned by hand. The use of electric and also pneumatic hammers, drills, grinders, etc., also lightens the work and speeds up the installation. The pneumatic type is used where compressed air is readily available and the electric type is used in more remote places.

Some jobs warrant the use of equipment just a little too large to be classified as portable; for example, a drill press, power hack saw, bender for flat or edge-bending of copper bus, a power driven jig saw and like equipment. All these tools increase in usefulness with an increase in the number of accessories usable with the tools; as an example, the threading machine cannot only be used for cutting, reaming, and threading pipe but also may be used for bolt stock. Pull lifts may be used for many purposes depending upon the slings and fittings which are supplied. The motor-operated winch may be used for not only pulling lines but also spotting equipment by the skidding method. Belt and disc type sander jobs are limited only by the variety of abrasive belts and discs used. The electric and pneumatic hammers and drills have almost an endless number of uses with the proper accessories.

The tedious job of star drilling by hand hammer is almost a pleasure with a small model of the pneumatic hammer. The jig saw even of the type normally used in the home workshop when supplied with the proper saws can be used on cutting transite and even light metal. The accessories should be right with the tools so that the workman is not compelled to waste valuable time by going to a shop every time a different accessory is required. This is where the portable tool buggies are most useful.

Beneath or above switchboards, control panels, control pulpits, etc., whichever is most convenient, we find that wiring troughs are most useful. This is also true at junction points for conduit runs. These troughs or metal junction boxes are a great time saver. Quite frequently, they eliminate the need of fittings and bends in the conduit when changing directions or going around obstructions. They serve as a convenient place to terminate circuits or make branch taps. Using standard

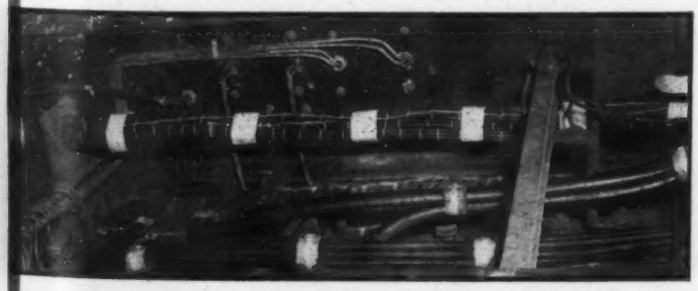
Small power hand tools as illustrated may be used for many tasks.

size switches and starters has enabled the installation crew to speed up their work. The lay-out is simplified because a standard print can be designated for the job which eliminates a great deal of work both in the drawing room and in the field.

The standardization of line hardware and cross arms for the several different voltages used throughout the plant has decreased the stock of materials which it was necessary to carry and has simplified lay-out installation work. After the conductors have been pulled into the conduits, we use portable type test telephones to identify the wires and then mark them with clip type metal markers. This method eliminates the danger of losing identification markers during installation or duplicating markers before the conductors are in place. It also enables the wireman to pick the conductors in proper order for making a neat, orderly wiring job. Small-sized conductors in small groups are banded with cord. The heavier conductors and larger groups are banded by a patented device which is a non-magnetic strap somewhat like a hose clamp; in fact, it may have been designed for that purpose. This band is tightened with a clamp tool. Between the conductors and the metal band, we place a few wraps of asbestos or glass tape to act as a cushion as well as an additional amount of insulation.

In conclusion, we should mention the most useful installation help anyone can have on any job — the good old-fashioned type of mechanic. A mechanic who knows his trade, takes great pride in a workman-like job, knows what materials to use, how to use them, and how to install them, does not need a foreman to line up each move for him during the course of the job. A man who believes in doing a day's work, whether he has one foreman or no foreman on the job, can take the manufacturer's print, get his own material from the store stock and when he is through you have a job that is not only well installed but also works without a score of so-called test men checking the installation before it is turned over to the operating force.

Small conductors in small groups are banded with cord.



Electric Shop Practices

. . . . the silicone varnishes, combined or used as a bond with glass fiber, mica, or asbestos, now produce an insulation which may be continuously operated at temperatures up to 175 C . . . .

by H. R. Larson

WESTINGHOUSE ELECTRIC CORPORATION

EAST PITTSBURGH, PENNSYLVANIA

▲ THE operating conditions largely responsible for failures to electrical apparatus may be grouped roughly as follows:

1. Dirt, which causes deterioration of insulation.
2. Moisture.
3. Excessive temperatures.
4. Excessive vibration.

It should be the repair shop's objective to restore damaged equipment to its original or new operating condition; incorporating, of course, such improvements in design as have been developed and as may be desirable and feasible.

Some preliminary remarks on methods of cleaning apparatus sent to the shop for repairs may also be of interest. Our present practices for cleaning electrical equipment employ high pressure steam and solvents, washing in spirits or solvents, immersing in caustic baths, and sand blasting.

For removing grease from windings which are to be saved, washing with steam pressure using a mixture of water and solvent has proved both effective and economical. Obviously, after such treatment a drying period is required in a baking oven. This is usually brief since the cleaning operation usually exposes the insulation to moisture a comparatively short time. Ball bearings and similar parts should be oiled promptly after such treatment to prevent rusting while awaiting assembly.

Sand blasting of other than machined surfaces has proved to be the most effective method for removing paint scale, rust and insulation; or in other words in getting down to the original surface of the metal. Our Pittsburgh shop has found sand blasting preferable to shot blasting.

In the foregoing, we have dealt only with cleaning of equipment after removal to shop for repairs, and I am also confining my remarks to rotating apparatus, for this represents the largest class of equipment sent to the repair shop.

A description of the tests made preliminary to installing the winding and between the various operations, up to time of shipment is given as follows, taking as example a Westinghouse MC crane armature or a high speed railway armature.

1. After stripping, a 2000 volt ground test on the commutator.
2. A 200 volt bar to bar test on the commutator.
3. Check the commutator for loose bars or other damage, such as loose commutator nut, damaged risers, etc.
4. Inspect for loose or burnt iron laminations.
5. Check shaft for true and damaged key ways, and journals.
6. After installing coils and before connecting top leads, light out for proper connection and check for possible short circuits between coils.
7. Test winding with 1500 volts to ground.
8. After installing top leads, check winding with growler.
9. After connecting, make bar to bar millivolt test.
10. Repeat the above test after banding and baking operations are completed.
11. Test with high frequency for possible coil faults.
12. Static or dynamic balance as required.

If dirt or injurious foreign matter cannot be kept out of machine in normal operation, then of course, the windings should be protected in the best possible manner with the insulation best suited for the operating conditions faced. At present, we are using a heat reactive synthetic base baking varnish commonly known as Thermoset varnish. This is a clear varnish of very good dialectric strength; has good penetration, and is

Presented before AISE Pittsburgh District Section Meeting, April 22, 1946.

Figure 1 — The motors are carefully inspected prior to steam cleaning.

Figure 2 — This motor, a 250 hp, d-c, mill drive was badly damaged in an overspeed wreck.

high in resistance to acids, oil and moisture. Repeated treatments will provide a film highly resistant to severe moisture, oil, and acid conditions. We are using this varnish in a general purpose manner, as it is available in grades for vacuum impregnation as well as dipping. We are using it for transformer coils as well as rotating equipment.

It is expensive, but baking time is relatively short. The baking cycle in use at our Pittsburgh repair shop on our No. 8826 varnish is six hours at 135 C for the first treatment, followed by eight hours at 135 C for the final. The baking cycle for coils in our coil department is but 1¾ hours at 135 C with this varnish.

Baking is, of course, done in an oven which constantly re-circulates the hot air, and which maintains temperature uniformly within close limits throughout the oven. The ovens are gas fired with provision for burning in the combustion chamber the volatiles given off by the varnishes at these baking temperatures.

MEETING HIGH TEMPERATURE CONDITIONS

Up to this time, temperature has been one of the most important limiting factors in electric machine design. This has been particularly true as long as we were dependent on organic fabrics and other organic materials for insulation. Through the introduction of materials such as mica, asbestos and, more recently, fabrics made of glass fibers, rotating electrical equipment is now operating satisfactorily at temperatures in some cases above 200 C.

While the inorganic materials referred to have been commonly applied for some time, it is only recently that the varnishes or impregnants available permitted full advantage to be taken of their heat resistant properties. The introduction of silicone varnishes to the electrical industry is making possible the application of a new class of electrical insulation. These silicone varnishes, combined or used as a bond with fiber glass, mica, or asbestos insulation, now produce an insulation which may be operated continuously at temperature of 175 C. This insulation will likewise resist moisture and will withstand tough service conditions generally.

From a material standpoint, we can, therefore, expect the following advantages:

1. Increased equipment life in locations subject to hot, as well as, wet atmospheres.
2. Greater freedom from failure due to overloads.
3. Reduced maintenance costs.

It should be realized, of course, that silicone insulated equipment is not obtained by merely immersing or painting a glass insulated winding in silicone varnish and baking. To obtain the thermal benefits from this varnish, it is necessary that conductors with silicone treated insulation be used to start with. Likewise, it is necessary that silicone bonded mica or glass cloth cell insulation be used and that similarly treated cloth and wedge material and wrapping tape be used. It is a waste of time and money to install high temperature insulation on the conductors, and then use class A material for filler strips or wedges.

High baking temperatures are required, in the range 200 to 250 C in order to cure the silicone resins, and shop equipment must include an oven of sufficient capacity with the necessary control equipment for this baking process. Our present procedure is to pre-bake at a conventional temperature of 100 to 150 C, gradually raising the temperature to 225 C for a 12 hour period, and finishing with a 3 hour period at 250 C. Obviously, any class A materials would be damaged or destroyed during such a treatment.

It should be realized that the effect of rebuilding a motor with high temperature silicone treated materials may merely transfer the weak link in the machine's ability to perform to some other point. It is our practice to carefully check the design of the machine before so proceeding, to insure that full advantage of the new high temperature insulation may be realized. For example, on a recent a-c motor submitted by a customer for rebuilding with silicone insulation, it was found desirable, if not necessary, to increase the air gap for

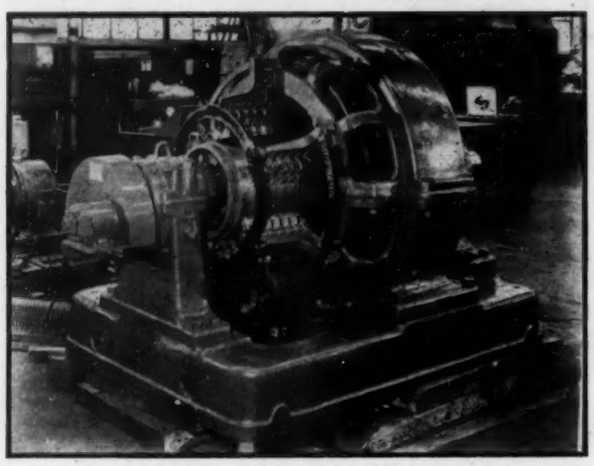


Figure 3 — This is the motor, shown in Figure 2, after repairs have been made.

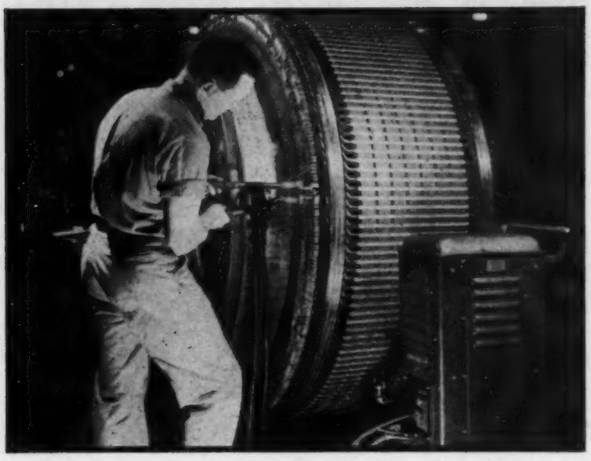


Figure 4 — The mechanic is here brazing high neck risers to armature coil ends.

additional clearances at the contemplated higher operating conditions. Similar conditions may be involved, in the case of ball bearings, and perhaps, in the construction of the squirrel cage windings. Obviously, the winding connections should be brazed rather than soldered, and the insulation on the motor leads must be likewise considered. Space considerations in the motor slots are also involved in using the new silicone treated materials.

We have not had as much experience in applying silicone treated materials to d-c machines, and in fact, our efforts so far have been confined largely to induction motors. The connection of the armature leads to the commutator frequently introduces a limiting factor from the standpoint of operating temperature. With high commutator risers, these should be brazed on all class B jobs rather than soldered. Tin melts at 232 C and if contaminated by as much as 2 per cent lead this value drops to 183 C. High temperature solders are difficult to work.

In brazing a standard type of neck or riser it is our practice to insert a thin strip of phosphorous and copper alloy between each of the armature coil ends and the neck. This serves as a brazing material for copper and copper base alloy materials. Heat from a brazing transformer is then applied with pressure to the joint by means of carbon tipped brazing tongs. After the phos-copper has melted, at about 815 C, and has flowed over the surface to be brazed, the current is interrupted, and pressure maintained until joint cools. A blast of compressed air can be applied directly to the joint when the current is shut off to accelerate cooling.

When brazing, no tinning of any kind is necessary on the open end of the commutator necks, although the armature coils are pre-tinned in the same manner as usual. However, when soldering with pure tin, pre-tinning must be done with pure tin, so as not to contaminate the final pure tin joint with lead. Pot soldering is done where quantities make it practicable.

At room temperatures, the phos-copper joint is approximately four times as strong as a perfectly formed soldered joint using pure tin.

Modern mill type series motor field coils have leads brazed to the conductor. Flexible cable leads are used. A copper tube is slipped over the bare un-tinned cable and both heated to a cherry red, thus wire and tube become a unit that is in turn brazed to the field coil conductor.

VIBRATION FAILURES

Vibration may be due to either mechanical or electrical unbalance of the rotating member or may be transmitted from external sources. One of the most important considerations in the life of electrical apparatus is to make everything tight and rigid or as free from vibration as possible. Pounding or vibration in a mill motor will cause insulating materials to loosen, and as soon as any movement or chafing has begun, this will increase progressively until insulation failures are experienced.

In this connection, it may be well to mention that crane and traction motor fields are subjected to heavy pounding. So are the armatures, but frequently, I am afraid, we replace armatures without giving consideration to the possibility of one or more field coils being shorted, and, therefore, impose above normal current requirements on the armature. Where repeated armature failures are experienced due to apparent overheating, it is desirable to remove and replace the field coils with new ones. I have reference to motors having strong series field windings, such as, crane, locomotive, and mill type machines.

Be thorough in weeding out all coils for which there is even the slightest question as to their condition. Don't take any chance, as leaving an uncertain coil in a motor will waste more material and time than the small amount seemingly saved. A motor with weak fields won't haul a normal load without distress to the armature.

If the past practice has been to remove a damaged armature from a frame, and then after a casual check of the field coils, put in another repaired armature, then by all means get all the field coils out of those frames, and have them checked internally as well as externally

Figure 5 — Sand blast cleaning of stator cores.

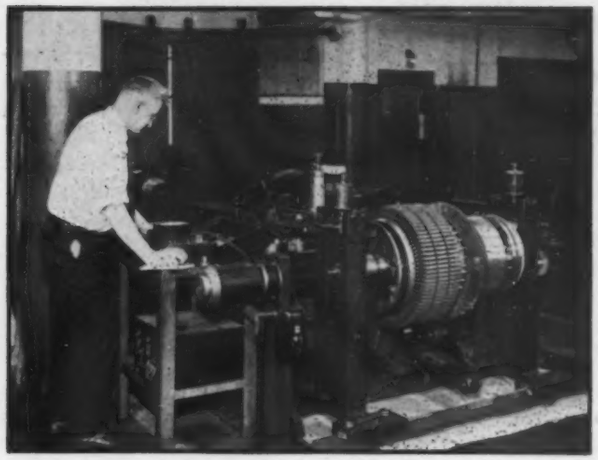


Figure 6 — The principle of dynetric balancing is here being applied to a generator armature core prior to installing windings.

before trusting a rewound armature in the doubtful field circuit. Engineering data and tests have proved what can and does happen in any series motor when turns are short-circuited in the main or commutating field coils. The results are an immediate attack upon the useful life of the armature windings, commutator, and remaining field coils.

Testing old field coils in the frame, or out, with the outer ground insulation in place will not in all cases reveal the true internal condition of the conductor insulation.

HIGH FREQUENCY TESTING

It is suggested that suspicious field coils be sent to a shop equipped with high frequency test facilities for checking. By this means, both existing and potential faults can be detected, and the coils in many cases repaired and returned with assurance of satisfactory performance.

Modern shop practice also provides for the high frequency test of wound armatures before shipping. All mill and traction type armatures rewound at our Homewood plant are so tested.

IMPORTANCE OF BANDING

We have previously referred to the importance of having windings tight and solid in operation to insure against loosening and chafing of insulation while in service. This is of particular importance in armature winding.

To begin with it is very important that a class B or high temperature job contain class B materials throughout. Under high temperature operating conditions, no job will remain solid and tight if fishpaper, friction tape or similar class A materials are used for filler or cushion pieces. The early deterioration of such materials under high temperature operating conditions will permit the windings to loosen and fail that much sooner.

Much depends upon proper banding of armatures. By this we mean using the proper materials, asbestos tape and not fishpaper under the bands, the proper grade and size of banding wire, and above all, the correct banding tension for the centrifugal stresses involved in the particular machine.

As to banding tension devices, there are tension devices on the market that will control accurately tensions from 25 to 600 pounds as required on banding wire without heating the wire. At 600 pounds tension, the wire can be held with the bare hand. These tension devices have automatic controls that indicate when the tension reduces or increases from the set value.

HOT TEMPORARY BANDING OF ARMATURES

One of the most important steps in steel mill motor armature winding is the preliminary or hot temporary banding after all coils are installed, and before soldering the leads into the commutator necks. When all coils are in and before the leads are soldered into the commutator, the armature is placed in an oven and heated until the core attains a temperature of 90 to 100 C.

Steel strips are provided for each slot of the same length as the top slot section of the coil, made square with each face and 0.020 in. less than the slot width so as to pull the coil down uniformly.

While the armature is hot, the core section is banded first with the same tension used for final bands, starting at the center of the core and working to each end, and then banding each coil end. Bands are left on until armature cools. This method of hot temporary banding permits pulling the winding down so that the final cold bands can lock the winding in place.

BALANCING

As previously stated, long life depends on a minimum of vibration in operation, and, of course, this depends on the rotating elements being in good balance to begin with. This is most important in machines operating continuously at constant speed as, for example, motor

generator sets, pump drives, and similar applications. To insure this means more than checking for static balance on a set of balance ways or knife edges. The principle of dynetric balancing was developed in the Westinghouse Research Laboratory, and the first model built in 1934. At the Homewood plant this principle of balancing was enthusiastically received by machine tool builders at the 1935 machine tool show, and we now have installed this type of equipment in most all of the Westinghouse repair shops.

The nodal bar balancing machine, consists of a nodal bar attached to each pedestal which enables the two unbalanced effects to be separated.

A light smooth belt induction motor drive rotates the body being balanced, from a speed as low as 200 rpm in the largest unit to as high as 2000 rpm in the smallest units. Unbalance correction to within 0.0002 can be obtained with this device.

Three sizes of machines are in use at our Homewood plant, the small machine being capable of measuring an amount of unbalance as low as ¼ gram or about 0.0002 amplitude, measured with a Davey vibrometer. Our large machine, which will handle pieces of 6000 pounds up to 7 ft in diameter, will measure an unbalance as low as ¼ ounce on a 1600 pound armature.

MACHINE OPERATIONS

To render a fully rounded service to industry in this area, some of our shops have found it necessary and desirable to go beyond electrical repair operations. In one case, we use a battery of two automatic welding machines for building up the worn treads of mining locomotive and crane wheels. During the critical material shortage of the past few years, this operation has, in some locations, been on an around the clock basis.

The process shown consists of feeding the electrode automatically at a rate corresponding with the speed of rotation of the tire which results in a fairly uniform and homogenous deposit of metal. This is then machined to the original tire and flange contour. With the proper electrode, wearing qualities equivalent to the original tire are obtained.

We expect soon to put in operation a modification of our present method. This will consist of depositing the weld under a flux which will, in effect, be a submerged arc welding process, also automatic in every respect. The rate of metal deposit will be much faster, the weld will be peened by air hammers as deposited, and tire breakage due to welding stresses are expected to be nil.

The practice of building up worn journals and gland fits by metal spray is well known. All well equipped repair shops have such equipment. Through the various alloy wires available it has been possible to spray coat steel with such materials as will resist corrosion under various operating conditions.

In presenting this subject, some of the material given may seem elementary; however, much of the matter represents tried and true material. The fact that it does work, however, and that it represents a method which is still in use after considerable experimentation with other schemes, may make it worth repeating. Cleaning and stripping practices, by and large, have changed very little and there is room for much more development in this end of the job.

In the correction of vibration we have accomplished much, and in meeting high temperature operating conditions, it looks as though silicone materials have opened new possibilities.

DISCUSSION

PRESENTED BY

JAMES FARRINGTON, Superintendent, Electrical Department, Wheeling Steel Corporation, Steubenville, Ohio

H. R. LARSON, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania

A. A. VAN PELT, District Manager, Norma-Hoffman Bearings Corporation, Pittsburgh, Pennsylvania

H. R. FORD, Assistant to Electrical Superintendent, Wheeling Steel Corporation, Steubenville, Ohio

R. S. HURTT, Assistant Electrical Superintendent, Crucible Steel Company of America, Midland, Pennsylvania

K. L. JOHANNSEN, Assistant Superintendent, Maintenance, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania

H. L. HUNTLEY, Headquarters Repair Sales Manager, Westinghouse Electric Corporation, Pittsburgh, Pennsylvania

J. B. ORTH, Supervisor, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania

H. L. COE, Assistant Superintendent of Maintenance, Carnegie-Illinois Steel Corporation, Clairton, Pennsylvania

W. E. WALDRON, Assistant Maintenance Superintendent, National Tube Company, McKeesport, Pennsylvania

J. S. RASHBA, District Manager, Rockbestos Products Corporation, Pittsburgh, Pennsylvania

C. R. BLACK, Supervisor, C. D. Maintenance Division, Westinghouse Electric Corporation, Pittsburgh, Pennsylvania

J. S. MURRAY, District Manager, Alliance Machine Company, Pittsburgh, Pennsylvania

James Farrington: There are two questions I would like to ask, one, have you had any trouble with the spraying of your metal on the shaft, so that after a short length of time that sprayed metal comes off, and the second question, what effect from vibration have you found on bearings?

H. R. Larson: Yes, we have had trouble with the metal coming loose, for we had quite a bit of difficulty breaking in people to do it properly. The process requires undercutting the metal somewhat with the proper tool and developing a technique to do it. It takes a good deal of instruction and you have to have a man who is conscientious and willing to be shown. On the

matter of vibration on the bearings, I am not aware specifically of any particular symptoms of the effect of vibration on bearings, at least, in the last few years. Do you have some particular point in mind?

James Farrington: Yes, I wanted to know if that resulted in the heating of the bearings?

H. R. Larson: Yes. We have had bearings that were subjected to vibration or an out of line condition, particularly roller bearings or ball bearings which have very little tolerance, and vibration affect will show up there quicker than anywhere else.

A. A. Van Pelt: Vibration will affect ball bearings much more than roller bearings. You will get a peening effect due to the small surface. You won't have nearly as much effect on the roller bearings, provided you have the proper tolerance on the roller bearing to begin with.

H. R. Ford: In the first part of your paper you spoke of steam cleaning. Do you use a neutralized soap solution or just steam?

H. R. Larson: Yes, a soap solution. I can't remember the name of it. I can find out about it if you are interested.

H. R. Ford: In regard to the dynamic balancer, is that one you make yourself?

H. R. Larson: Yes.

H. R. Ford: Is it available for sale?

H. R. Larson: We license that machine to the Gishhold Machine Company, who are located up in the New England area. We are not building that machine for direct sale, but it can be purchased through the Gishhold Company.

R. S. Hurtt: Has there been a wedge developed yet that will withstand the heat of your silicone insulations? In other words, I have used glass insulation on some coils and have been forced to use a glass-backed bakelite. In time the backing varnish or body has charred out, and just left the glass backing. I would like to know if there is any wedge material that will withstand it?

H. R. Larson: Yes, there is an asbestos-base material, silicone impregnated that we are using.

R. S. Hurtt: Can it be machined?

H. R. Larson: Yes, It can be readily machined. I think you will find that available on the open market.

K. L. Johannsen: I would like to ask about the grease that you mentioned was used in connection with the silicone wound machines. Is that merely a high temperature grease or is it made especially for silicone machines?

H. R. Larson: It is tied in with the silicone. I am not able to give you all the information on it, but I know we use it. I am not sure how high you can go in operating temperatures with it.

K. L. Johannsen: Do you supply it?

H. R. Larson: Our company doesn't supply it, but it is available on the market.

H. L. Huntley: I think you will find that the manufacturers of silicone varnishes are very much interested in overall performance of silicone treated apparatus. Dow Corning is one manufacturer. I cannot give you the information at this moment, that you desire as far as high temperature greases are concerned on bearings, but understand it is working out very well. I suggest therefore you ask the Dow Corning Company for their recommendations.

H. R. Larson: That is a good suggestion and should be helpful due to the vast experimental work Dow Corning is conducting.

A. A. Van Pelt: In line with the silicone greases, I have some information on tests that have been run recently. So far as I have been able to find out, a lithium base grease has been one of the best greases for high temperature, and at 300 F, the tests were only run at 300 F, the silicone greases lasted over six times as long as the lithium soap base grease and were at that time still in good condition. So we don't know how much longer they will last and we haven't run a test yet at higher temperatures than 300 F.

H. R. Larson: I think we do have to watch the clearances, particularly, the ball bearing clearances when we get up into that range of temperatures. That is something that should be checked with the ball bearing manufacturers.

A. A. Van Pelt: That is true, not only on that application but on all steel mill and mine motor applications. The internal clearance of either the ball or the roller bearing is a very major factor in the life that you can get from the bearing. You can take a bearing and put it in a mine motor with the same clearance as one on a machine tool spindle, and burn the mine motor bearing up in about an hour because it is running tight. You have to have your ball or roller bearings with a certain amount of clearance, which is predetermined, or else you are going to get very short life.

J. B. Orth: I would like to ask if the reason for not using silicone varnish for d-c armature construction is because of the commutator construction?

H. R. Larson: Yes, principally so. If we are going to use the maximum that the varnish will permit, then we begin to have trouble with a weak link, for example, the commutator mica. That mica has a shellac bond now, and, if we are going to deal with the temperatures that you are talking about in insulating the coils, we have to consider what is going to happen in the bond in the mica as well.

J. B. Orth: Do they not have mica that is bonded with glass?

H. R. Larson: Yes, there is one bonded with silicone, but of course it is a little more complicated job than in taking an induction motor, where there you are merely dealing with the coils and the connection of those coils, one with the other. In the armature we are dealing with the mica and the shellac bond, which will have to be replaced with a silicone-bonded mica, plus the fact that on the solid-neck riser armatures, you do have a problem there in getting a high temperature connection between your coils and the commutator necks.

Now you can do it with brazing. On the solid necks you can braze the top lead, but how are you going to get down to the lead below that? That requires using a pure tin solder, which I think has a temperature of 300 or thereabouts, and pure tin is hard to work. So you do have a link in there that puts the possibility on the borderline; therefore, it is a little more difficult to insulate for as high a temperature in a d-c armature than on an induction motor.

H. L. Coe: Two or three things I thought of when

Mr. Larson was talking. I was wondering how the lamination insulation on a-c equipment stands up under this high temperature at which we are supposed to run silicone varnish and oils? At what temperatures does varnish film on laminations break down? If you get a motor or generator too hot, there is danger of breaking down inner lamination insulations, and hot spots develop in the iron.

Another thing I was thinking of is that with d-c equipment one is likely to get into considerable commutation trouble if temperatures are increased beyond a certain point, due to brush disintegration and commutator oxidation. These things will make it impossible to operate d-c equipment at high temperatures, unless commutators are made out of some non-oxidizing material and a non-oxidizing brush is used. I would be interested in knowing about how hot you can go, in general, with a-c equipment and d-c equipment without special design throughout.

H. R. Larson: I don't know, but I believe the Reliance Electric Company ran some tests, on an induction motor subjected to a temperature on the order of 400 C. It failed and was torn down thoroughly, and they found that the silicones had reverted back to their original sand. But that seemed to be the weak spot rather than the insulation between laminations.

That doesn't necessarily mean that is going to remain the weak spot, for you may have trouble with the laminations. I haven't seen any evidence of that yet, and I haven't heard of any.

H. L. Coe: It has been our opinion for a good while that there are so many other points at which equipment will fail at high temperatures, such as beyond 150 F, that one would not be justified in spending the money on any existing equipment. One would have to build the equipment from the ground up for such temperatures before it would be justified. I don't know whether that is your opinion or not.

H. R. Larson: We haven't seen yet to what extent silicones are going to change the design of new equipment; at least so far in talking to designers I haven't been able to visualize it yet. So far, we have applied it where we have been in trouble, because the insulation was the main weak link, and we have solved that. What you say about the d-c equipment, brush life and so on, is a very good point.

H. L. Coe: In your discussion, I notice you didn't mention any infrared baking or drying equipment in your shop, and I wonder if Westinghouse has been doing any? At our plant in Clairton, we are doing practically all of our varnish baking and drying by infrared heat, and have found it very economical. We have developed several special attachments for various layouts, such as commutator baking, inside of squirrel cage stators, and various items of that type. I wondered if you have had any experience in your own shop as yet?

H. R. Larson: Yes, we have. So far, we have been using it as a portable device in our repair shops. In our manufacturing process, we have been using it in heating units on conveyors, and it has been very effective.

In the repair shops we have been using it largely as a portable device, where we had to bring the heat to the equipment. The oven, in the figure, represents our present practice of baking. We have a very efficient oven, which happens to be gas-fired, and therefore particularly suitable for this work, and are getting very satisfactory results with it. We haven't put infrared heat in ovens of that type here.

W. E. Waldron: I would like to ask a question. I noticed that the operator of the cleaning device was not equipped with any protective equipment. Is it ever necessary for the operator to be equipped with a gas-mask or respirator?

H. R. Larson: No, we have pretty good draft on the booth and we have no trouble. In the particular location I am most familiar with, the man wears boots, and of course gloves. The ventilation there is good enough so that the steam doesn't bother him. It swishes right out past him, and of course he keeps his steam nozzle between himself and the exhaust.

W. E. Waldron: Was that booth enclosed?

H. R. Larson: You can't entirely enclose a booth like that, for you have to provide very positive ventilation. We have a very high suction blower that draws up the vapor very rapidly.

In the sand blast room, of course, the man is equipped with a mask, just as you mentioned, so he can breath outside air while he is working in the sand blast room. But it hasn't been necessary in the steam cleaning.

J. S. Rashba: As I understand your statement, on the silicone wire you spoke of desirability of impregnating the insulated conductor, first coating the conductor with silicone compound, and then the insulation after it has been put on. The thought I have is, do you cure the insulated wire at this stage or form it into a coil while it is wet and then cure the finished coil? It is my understanding that in view of the high temperatures necessary, curing the individual conductor would become a very expensive operation.

H. R. Larson: I am not familiar with the production of the insulated wire. What I had reference to, I hope I didn't mislead you, was the necessity for having the insulated wire, before we attempt to use it, also treated with silicone. That is, the insulation is treated, as the wire is insulated. Now we ourselves have been doing that, not on a production basis so far, but on a limited basis, and I am not familiar with that process. Someone here from some of the wire companies might tell us more about the manner of treating the insulation when it is first applied to the wire.

C. R. Black: May I add a word? In treating the insulation on wire with silicone varnish, it is necessary to treat it so that there is flexibility to the finished product. Finished windings are baked at a temperature of about 250 C and when aged at that temperature the finished winding is somewhat hard. We have three cycles of treatment, viz. drying, curing and aging. The object in treating the insulation on the wire is to dry it. This is done by elevating the temperature for a short period of time. This does not set the varnish sufficiently to cause the insulation to break in bending or to make the wire too stiff to wind. Other insulating materials, such as slot insulations, that are treated with silicone varnish, are treated much the same as the wire insulations and for the same reasons.

J. S. Rashba: We manufacture insulated wires for high temperature application, and one of the wires we make for the aircraft industry calls for 400 F service

application. The only way we could arrive at a satisfactory wire was silicone impregnation of the insulation and the outer glass braid. Because of the high temperature necessary to cure the silicone and the attendant slow speed of the process it becomes a very expensive wire to make. When you made the statement that it is desirable to impregnate the conductor with the silicone, I was wondering how you actually worked it out in practice without running into terrific expense.

H. R. Larson: As I recall, the relative cost of silicone and ordinary glass is on the order of three to one. But we are not sure that is the real cost, because there is some development to be done. As you say, it is terrifically expensive to run the process slow enough to cure it. But it is not entirely cured because that winding is going to get a further treatment in the oven, and so you might say it is only half cured when applied to the wire.

J. S. Murray: In connection with Mr. Larson's paper, I would like to point out that the silicone sheets used in the cores of electrical equipment employing high temperature insulation can be secured from several sheet manufacturers with a very thin coating of flashed on insulation that will withstand temperatures up to 1500 F. The stacking factor in the cores is not affected by this sheet coating, and I believe that you will not have to worry about interlamination breakdown at operating temperatures. It would be well to avoid so called baking or air drying varnishes on such core material at these high temperatures, as most of the non-flashed varnishes will "run" or soften up at 55 C. This may clear up the question asked by Mr. Coe of Carnegie-Illinois Steel Corporation.

We all hope that our war experience with better insulating materials, steel cores, anti-friction bearings and improved methods of ventilation will result in superior electrical equipment in the future.

Abstracts of papers

TO BE PRESENTED AT ANNUAL AISE CONVENTION

PUBLIC AUDITORIUM, CLEVELAND, OHIO, OCTOBER 1, 2, 3 and 4, 1946

MEASUREMENT OF HEATING RATE IN REHEATING FURNACES

By J. W. PERCY
United States Steel Corporation

This paper describes the equipment and method used in measuring surface and center temperatures of billets or slabs as they pass through continuous reheating furnaces. This method was used in extensive tests and the paper gives some data obtained from these tests on the heating rates of commercial three-zone top and bottom fired furnaces.

AUTOMATIC WELDING IN STEEL PLANT MAINTENANCE

By H. E. HOLMAN
Jones & Laughlin Steel Corporation

Automatic welding has been accepted in recent years as one of the means of reclaiming worn cylindrical parts at the Jones & Laughlin Pittsburgh works. The material is presented to point out to prospective purchasers and operators of this type of welding, some of the major handicaps which must be overcome and some of the constant problems encountered in the way of permanent and mobile equipment. Many fundamental requirements are suggested and an attempt made to illustrate that a large portion of those requirements can be developed and fabricated in the plant. A brief description is submitted of how the process functions along with a few of the important variables such as amperage and voltage ranges, speed of travel, wire burn off rate, welding machines and wire supply. The paper is concluded by listing examples of the most common applications.

ELECTRICAL EQUIPMENT FOR THE SENDZIMIR PRECISION COLD STRIP MILL

By H. W. POOLE
General Electric Company

The Sendzimir cold strip mill, as its name indicates, is a "precision" mill and as such it requires precision electrical equipment.

This paper deals with electrical equipment for reversing cold strip mills in general, and the specific application of this equipment to the Sendzimir mill. Such items as the following are discussed:

A. Selection of main drive motors, inertia, etc.
B. Selection of reel motors, inertia, speed range, etc.
C. Methods for obtaining high tension on first few passes and lighter tensions on later passes.
D. Electric control systems for obtaining constant speed and tension, inertia compensation during acceleration and deceleration, and stalled tension at standstill and during reversal.
E. The use of constant current regulators and tensiometers for controlling reels.

MACHINERY FOR ROLLER LEVELING FLAT ROLLED METAL

By A. J. WARDLE, JR.
McKay Machine Company

Roller levelers have been used mechanically for straightening and flattening flat rolled products since about 1860.

Roller leveling machines in the beginning were rather crude affairs. Some of the very earliest types consisted of three or more rolls where the upper rolls were nested between and above the lower rolls with pressure applied against the sheet by a foot treadle that was worked by the man on the finishing side of the mill. This type of machine was driven with spur gears mounted on the end of each roll. Later more rolls were added and arranged with four worm and gear hand-operated screw-downs. The principal disadvantage of this arrangement when adjusting the leveler for various thickness of material and degrees of flatness was that the spur gears were often times out of mesh from the pitch line which resulted in a certain amount of slippage that produced cross marks the full width of the material, and which is commonly known in the trade as "chatter" marks.

The next important development consisted of removing the pinion gears from the ends of the rolls and arranging said pinions with the necessary reduction in an enclosed gear drive, with all output shafts connecting with their respective rolls thru universal couplings. With this plan, the roll pinions were always in proper mesh resulting in an improved product.

The latest major development comprises the entire field of what is known as four-high or backed-up roller levelers. This design has the advantages of employing smaller diameter work rolls with all work rolls supported by back-up or supporting rolls to prevent roll deflection. This type of leveler has proved to have many advantages particularly when leveling light gauge materials which have the effect of breaking and flexing the material on shorter centers.

THE CORRUGATING OF SHEET METAL

By JOSEPH E. KIEFER
The Streine Tool and Manufacturing Company

The first roll corrugator came into existence in the year 1885, the corrugations being planed in the roll proper. Due to the inaccuracy of machining and the various range of gauges to be corrugated, these rolls did not work out satisfactorily. In 1898 these rolls were replaced by hexagon shape rolls on to which were bolted the dies. These dies could be replaced by other dies to suit any gauge to be corrugated.

As the years passed, the demand for a more perfect corrugated sheet became greater and greater. As a result of this it became necessary to re-design the corrugator to meet these demands. Forged steel hexagon rolls replaced the cored rolls. The analysis of the material for the dies was changed, back lash gears were added to prevent the jumping of the rolls, accuracy in machining was held to within thousandths, and many other changes were incurred to produce this more perfect corrugated sheet. There has been considerable trouble experienced in the designing of "V" crimp, channel drain, and corrugating dies, inasmuch as there were a number of factors to keep in mind, such as the breaking of the galvanized coating, the vast difference between the hand rolled sheets versus continuous rolled strip, and the variation of steel from one mill to the other.

There are two distinct classifications of dies, the first being dies to corrugate roofing and siding, and the second dies for "V" crimp and channel drain roofing.

The first classification includes the following dies:

1¼ in., 2½ in. light, 2½ in. medium, 2½ in. heavy or culvert, 3 in. British or export, 3 in. American, and 5 in.

The second classification includes the following dies: 2 V-crimp, 3 V-crimp, 4 V-crimp, 5 V-crimp, 6 V-crimp, and various shapes of channel drain.

There are three distinct types of corrugators. One of these types has six-sided rolls accommodating two sets of dies and is fed by an oscillating table operating at a speed of 4-12 rpm with a capacity of 12 gauge and lighter sheets 12 ft long. This machine is used mostly for corrugated sheets.

A second type machine has six-sided rolls accommodating two sets of dies and is fed by a chain table operating at a speed of 8-24 rpm with a capacity of 12 gauge and lighter sheets 12 ft long. This machine is used mostly for corrugating "V" crimp and channel drain products.

The third type has nine-sided rolls accommodating three sets of dies and is fed by a chain table operating at a speed of 4-12 rpm with a capacity of 8 gauge and lighter sheets 14 ft long. This machine is used mostly for corrugating culvert stock.

The greatest advancement in the past years in corrugating has been in the dies which produce the various products.

POWER AND POWER FACTOR IN ARC FURNACE OPERATION

By EARLE H. BROWNING
Westinghouse Electric Corporation

One of the important considerations in the operation of direct arc electric furnaces used for steel making is that of obtaining satisfactory power factor conditions. Since reactance in electric arc furnace circuits is necessary for both arc stability and current limiting purposes, it is supplied inherently in the transformer, buswork and leads used and in some furnace circuits by supplementary reactors. Thus with reactance in the circuit, the power factor obtained during operation is in part a function of the arc resistance as determined by the electrode positioning with respect to the charge. The value of arc current utilized is governed by arc length, and is subject to practical limitations based on analysis of useful power input to the furnace.

The paper reviews the general electrical characteristics of furnace circuits and indicates conditions having marked effect on power factor and useful power input. The desirability of conducting tests on existing furnace installations is stressed. By examining quantitatively

the factors which point to the means for securing optimum performance for a given furnace, definite operating specifications can be set down and enforced.

Methods for assuring desired operating conditions are pointed out and the use of auxiliary equipment with present arc furnace regulators for aiding operators to realize best overall production results are discussed.

ROD MILLS AND ROD MILL ROLL DESIGN

By ROSS E. BEYNON
Carnegie-Illinois Steel Corporation

The paper deals with the evolution of rod mills from the earliest times to the present day. It touches briefly on the mills which were in use for producing rods previously to the mills of Henry Cort and describes mills similar to the Cort design. The Cort mills were built at Fontley, England in 1783 to 1785. The so-called Belgian rod mills which were the popular rod mills of the early days, at first consisted of three stands, and gradually grew to seven in line. The addition of the separate three-stand roughing section to the Belgian mill appeared in 1838.

The first continuous mill for rods was invented by Bedson in 1862, and improvements were gradually added.

In 1882 and 1886, the first and second Garrett patented mills were built. This type first found favor and then gradually declined, while the continuous mill progressed further.

The paper also discusses roll design practices, and the progress made in the rolling of rods.

THE CHEMICAL REMOVAL OF SCALES, SLUDGES AND OXIDES FROM BLAST FURNACE COOLING SYSTEMS AND ALLIED STEEL MILL EQUIPMENT

By B. H. McDANIEL
Dowell, Inc.

Due to the large quantities of water used in the cooling coils of blast furnaces and other steel mill equipment, deposits of various types scales, sludges and oxides are formed which greatly reduce heat transfer efficiency.

While the application of chemicals for the purpose of removing these efficiency robbing encrustrations is not a new art, important improvements have been made in recent years, both as to the range of solvents employed, the technique of their use and heavy mobile equipment for their transporting, mixing and introduction. One of the most important developments has been in the field of inhibitors, highly effective agents now being available which protect the various metals of a vessel at elevated solvent temperatures.

Chemical scale removal, properly used, is thorough and economical, requiring only a minimum of downtime for the units involved. In the case of the blast furnace and certain other installations, the unit need not be removed from production. No system is too complex or inaccessible to be reached by the solvents and no extensive preparation or dismantling of the unit is entailed.

THE MANUFACTURE OF OXYGEN IN LARGE QUANTITIES FOR INDUSTRIAL USES

By MARTIN J. CONWAY
Steel Industry Consultant
Stacey-Dresser Engineering

Two oxygen plants have been contracted for to produce 40,000,000 cu ft of oxygen per operating day. The first unit, now under construction at Brownsville, Texas, is to operate in connection with the Hydrocol process for the processing of 64,000,000 cu ft of natural gas per day to produce rich motor fuel, synthetic diesel oil and crude alcohols.

It is of interest to note that the oxygen unit of the Brownsville plant will be the largest thus far built. Compressing air to 75 pounds, it will produce oxygen at an estimated cost of 4.8 cents per 1,000 cubic feet. This figure is based on an investment of $3,500,000 for the plant and includes amortization, maintenance and operating labor. Power (amounting to less than 14 kw per 1,000 cu ft of oxygen) and water costs are excluded from the cost of manufacture as they are both available as by-products of the process and are automatically covered in the price paid for the natural gas.

This process, including the oxygen unit, has back of it over a million dollars of experimentation. The oxygen process consists of four parts, namely, air compression, heat exchange, refrigeration, and fractionation.

Air compression — The air is compressed to 75-85 psi in two stages with coolers after each stage, passes to a surge drum, then through a filter to remove dust and entrained moisture, and finally through a bed of activated carbon pellets to absorb hydrocarbon vapors.

Heat exchange — The air then passes through a reversing exchanger where it is cooled by the return oxygen product and the waste nitrogen gas. The air feed and the waste nitrogen stream are passed alternately through the two outer annuli of the exchanger and the change is effected every three minutes by a piston operated valve. The air leaves the exchanger at approximately minus 250 F and the main portion of the air is further cooled by exchange against the waste nitrogen before entering the high pressure column.

Refrigeration — The balance of the air passes to a surge drum and then through expanders. These expanders remove some of the heat from the gas at work, which is expended in compressing a small amount of air. This operation supplies the refrigeration necessary to compensate for the heat leakage into the system and the heat loss of the product streams relative to the incoming air stream.

Fractionation — The high pressure column separates the air into an overhead liquid product of essentially pure nitrogen and a rich oxygen bottom product. Both liquids are subcooled by exchange against the overhead vapor from the low pressure column. The liquid nitrogen provides reflux for the low pressure tower and the rich oxygen provides the feed to the column.

The oxygen product is withdrawn from the bottom of the low pressure tower as a vapor product and passes directly to the reversing exchanger and on out into the service line.

E. A. W. Jefferies presented a paper at the annual

convention of the Association of Iron and Steel Engineers in 1921, titled "The Influence of Cheap Oxygen on Economy of Fuel and of Time," in which he visualized with uncanny foresight many of the uses for oxygen which are being actively tested in several plants at the present time. We are now in a position to fulfill some of Mr. Jefferies' prophecies in that oxygen can be produced cheaply for metallurgical uses by a dependable, relatively trouble-free process which requires about the same caliber of attendants as at present employed in sections of by-product coke plants.

IRON ORE RESERVES OF THE MESABI RANGE

By E. W. DAVIS
University of Minnesota

For nearly 50 years, the Mesabi range has provided the bulk of the iron ore requirements of the United States. This range can continue to supply the major portion of our ore requirements for another 100 years or more, but only with great changes in the ore mining industry. Preliminary preparations for these changes are now underway.

Nearly a billion and a half tons of high grade iron ore have been shipped from the Mesabi range, and about a billion tons of the same type of ore still remain. The remaining ore, however, is not divided among various steel companies according to their requirements, and some companies are finding it necessary to develop new reserves.

There are vast quantities of taconites, composed of fine grains of magnetite and hematite finely disseminated throughout the rock mass, and averaging about 30 per cent iron. Several companies have already acquired great areas of taconite and are actively engaged in developing these properties and studying concentrating characteristics. If economic methods can be developed for the concentration of taconites, these companies will have ample ore reserves for years to come.

Preparation of usable ore from taconite calls for mining, crushing, grinding, concentrating and agglomerating. Experience has shown that a plant to produce a million tons of agglomerated ore annually will cost about 10 million dollars, and that this ore can be produced at a cost only slightly above normal ore prices. Experiments have also shown that high grade magnetite sinter gives a considerable saving in smelting costs. Hence, the cost of producing pig iron may not be seriously affected.

If this development comes, we will have an almost inexhaustible supply of iron ore within the borders of our own country. Otherwise, many steel companies must look to foreign sources for future ore supplies.

REFRACTORIES VERSUS COMBUSTION IN STEEL MILL FURNACES

By EDWIN N. HOWER
Carnegie-Illinois Steel Corporation

Improvements in combustion practice have resulted in more severe service conditions for furnace refractories. The most important of these changes during the past fifteen years has been the gradual change of operating pressure in the body of most furnaces from a negative to a positive value, with consequent elimination of air infiltration. Changes in furnace design and in refractory materials used to offset this condition are discussed in this paper.

Several examples are given of combustion changes which caused refractory failures, the cost results of these changes, and the steps taken to correct the costs. One case history is given in detail with an examination of various interrelated factors such as scale loss, operating time and cost, etc., in addition to the obvious costs for fuel and furnace repairs.

The paper closes by stressing the need for close cooperation between the operator, the design engineer, the combustion engineer and the furnace brick mason, as each has a vital share in the overall performance and cost.

IMPROVED DESIGN OF METALLIC RECUPERATOR

By FRANK D. HAZEN
Hazen Engineering Company

The use of preheated air for burning fuel has been employed for many years and in most cases economically so. It is a recognized fact that in the production and processing of steel the money spent for fuel is considered one of the major expenditures. With the installation of a properly designed recuperator, considerable savings can be accomplished with nothing more than the original expenditure.

The price of most fuels has already been increased, and with industry facing possible additional increases in fuel prices, any saving in this direction should be of paramount interest to management.

Various types of recuperators have been used over a period of many years. The success of the recuperator has been predicated upon the length of time it is able to produce the required preheated air at a minimum maintenance cost.

Although not a new idea, metallic recuperators have been improved in design and construction. One of these designs consists of header boxes located above the flue; the flue may be located most advantageously, either above or below ground. Suspended from the header boxes are the heating elements consisting of inner and outer tubes, which are for the most part made of stainless steel sheets.

Both outer and inner tubes are suspended from the top only, and are free to expand independently of each other, regardless of the existing temperature differences. Complete elimination of air or gas leakage thus provided permits the use of high forced air velocity resulting

in rapid heat transfer rates, which keeps the metal temperature of the outer tubes low as compared with that of surrounding flue gases.

The fact that these tubes are formed of stainless steel sheets rather than cast alloy makes it possible to use a thinner gauge of metal, and further contributes to this rapid heat transfer and cooler metal temperatures.

In this design, any row of elements, or any individual element (inner or outer tube) may be replaced rapidly and without removing the boxes from their locations in the flue.

Recuperators of this improved design have been in service for four years, and have given excellent results. At the present time five units of this modern design are under construction. When completed, this will represent one of the largest single installations of metallic recuperators ever built.

STORAGE YARD MATERIAL HANDLING

By FRANK C. WIER
The Timken Roller Bearing Company

The paper discusses the arrangement, handling methods, equipment used, personnel and general operation of the storage yard located at The Timken Roller Bearing Company, Canton, Ohio, serving the Steel and Tube division at the Canton and Gambrinus plants.

The paper deals with the problems pertinent to the alloy steel producing mills which require extremely flexible material handling facilities, accurate inventory controls, and careful segregation and identification of various types of scrap and raw materials.

The following points are considered:

1. The general type of yard showing the railroad track layout and type of equipment used.
2. The supervisory and maintenance set-up listing the personnel required.
3. The types, methods of handling, stock piling and reloading bulk materials in the yard.
4. The storage of spare parts and idle machinery with short cut method for handling same.
5. The handling of blooms showing inbound control, method of storing and plan of ordering for reloading.
6. The handling of semi-finished tubes and bars to relieve congestion in finishing departments.
7. The preparation of scrap in the yard.
   - A. Sorting scrap tubes for alloy types.
   - B. Shearing scrap.
   - C. Burning scrap.
   - D. Handling non-magnetic scrap.
8. The handling and storage of scrap.
   - A. History.
     1. Inside storage.
     2. Outside storage.
     3. Large piles.
     4. Small piles.
   - B. Method of handling and storing.
     1. Control of inbound materials.
     2. Piling system.
     3. Numbering and identification system.
     4. Ordering system.
     5. Yard capacity.
   - C. Inventory.
9. Conclusions.

A NEW METHOD OF STRIP COIL ANNEALING

By H. H. ARMSTRONG and F. F. SCHLITT
Lee Wilson Engineering Company, Inc.

The end of the war gave a new impetus to technological development in the strip and sheet industry in the direction of increasing capacities and improving quality of material.

Changes in processing in the industries which use coiled strip and tin plate have made it possible to think in terms of greatly increased coil diameters and the lack of floor space for immediate expansion in the mills has caused consideration of piling the coils to much greater heights than have ever previously been considered.

These two factors in the sizes of material and weights to be processed in annealing coiled material have made it necessary to view the problem in the light of some improved method of applying heat to the coils in the process. For a matter of years it has been known that if the heat could be applied to the edges of coils rather than through the laminations for annealing, the material could be heated much more uniformly and much faster.

A new annealing method has been developed to accomplish this edge heating and this paper covers details of this application and presents data to show actual results from installations which are already in operation embodying this new principle of heating steel coils.

MODERN TRENDS IN BRUSH OPERATION

By LEON D. COOK
Commonwealth Edison Company

In appraising the trends in brush operation the author sums up the latest theories relative to the passage of current through moving contacts. This is followed by a discussion of the effect of collector skins on brush operation, together with practical suggestions for the forming and preserving of desirable surface films.

Consideration is given to practical mechanical matters connected with brush operation. This paper differs with previously published instructions relative to brush seating and installation. The author gives his reasons for disagreement and recommends a procedure he considers superior to past practices.

The methods and reasons for grooving rings and commutators are discussed together with the action of current passing between altered brush and collector surfaces. Much of this discussion has not been published.

The effect of humidity on brush operation is considered. The required water content of air is given for the safe operation of brushes on high-speed machines.

The scope of this paper is the discussion of modern methods of brush operation following the introduction of higher speed and heavy current machines of recent design.

THE USE OF TENSION IN SIZING SMALL DIAMETER SEAMLESS PIPE AND TUBING

By S. W. STOUFFER
National Tube Company

One of the more important developments contributing to the improvement in productive capacity of small diameter seamless tube mills is the use of tension in the final sizing operation on the hot mill. The application of this principle not only permits substantial reductions in wall thickness of the tube to be made in the sizing mill, but also provides a means for making exceptionally large reductions in the diameter of the tube with a relatively small number of roll stands. These features overcome one of the principal obstacles to the rolling of small diameter seamless pipe, namely, the inability to make large diameter reductions in the sizing mill without adversely affecting the quality of the product.

In this method of sizing, tension is developed in the tube section by increasing the relative speeds of the rolls in successive mill stands to a greater degree than required to compensate for the change in section area produced by the reduction in the several roll passes. The tension, or pull, thus applied to the tube as it passes between consecutive stands produces a slight reduction in the area of the section by stretching. Since the piece is in tension, the resultant metal displacement goes into elongation and a reduction in the wall of the tube is thus effected. With the application of sufficient tension, the reductions in wall thickness developed between stands can be made to exceed the amount of thickening produced by the compressive forces developed in the roll pass, thus permitting the production of finished tubes of lighter wall than the entering shell.

The sizing of tubes by the use of tension, or "stretch-reducing" as it has been termed, introduces an objectionable operating feature, namely, the end thickening of the wall of the reduced tube caused by the non-uniform application of tension to the tube as it enters and leaves the several stands of the sizing mill. The problem of controlling the amount of end thickening, along with the achievement of the desired diameter and wall reduction in the stretch reducing operation, serves to make it a complicated procedure requiring specially designed equipment and carefully planned operating schedules.

Based on results of a series of controlled stretch-mill rollings, the factors which determine both wall reduction and end thickening have been fairly well defined. The amount of wall reduction which can be produced is primarily controlled by factors which determine the tension applied to the tube, as well as the ability of the tube to withstand the effects of such factors without damage. The more important items included in this category are: diameter of rolls, diameter reduction of tube per roll stand, initial diameter and wall of the tube, overall diameter reduction of the tube, and roll speed ratios. End thickening is also determined by a wide variety of factors, including: motor speed characteristics, center distance between consecutive roll stands, tube size, overall area reduction of the tube, and diameter reduction of the tube per roll stand.

In addition to a discussion of the manner in which these factors influence wall reduction and end thickening, the article deals with special mill design features and motor characteristics required for satisfactory utilization of the stretch-reducing principle.

SUBMERGED COMBUSTION IN INDUSTRY

By W. G. SEE
Submerged Combustion Company of America

Although submerged combustion for heating and agitating pickling solutions has been in successful operation for quite some time, the steel industry generally was inclined to think of it as a "new development" until the past few years, during which the process has made a place for itself simply by living up to its claims of producing more pickled steel at a lower cost.

While the older installations are still operating, the newer ones are proving that the low costs and high production figures made by early users were not isolated instances, but rather were indicative for the pickling field as a whole.

The submerged combustion system consists of a control assembly designed so that the operator or watchman has only to press a starting button to put the entire unit in operation. All the workings of the unit are completely automatic, and once started, the unit operates to maintain the set temperature of the pickling bath by turning the gas on and off as required, until it is finally shut off when the pickling turn or period is completed.

One user pickling sheets reports that pickling which required 20 to 25 minutes was reduced to 5 minutes. Other materials which required as much as 45 minutes are now finished in 12 minutes.

Another user shows a drop in acid cost from 23.1 to 18.4 cents in bar pickling, a reduction of about 20 per cent.

Other advantages reported by various users include reduced maintenance, less capital equipment tied up in pickling departments, elimination of steam costs and elimination of solution dilution.

SOLUBLE OILS FOR CUTTING AND GRINDING OPERATIONS

By C. M. LARSON
Sinclair Refining Company

During World War II, when the cutting and grinding of metals played such an important part in the war effort, it was necessary to expand our knowledge of cutting fluids in order to keep pace with production requirements. Through research, experimentation, and cut and try methods, cutting fluids' efficiency was greatly increased, far beyond the rule of thumb methods of the expert. So today a new peak of machining and grinding perfection is reached, both in production rates and surface finish. Soluble cutting oils naturally played an important part in this achievement.

It is generally agreed that plain water was the first medium used to offset the generation of frictional heat in metal cutting. In 1883, F. W. Taylor, a pioneer of cutting oil research, demonstrated that when directing a heavy stream of water upon the cutting tool at the point where the chip is torn from the turning steel, the

cutting speed could be increased 30 to 40 per cent. Water alone does not generally give a smooth surface. Due to its low viscosity and poor wetting ability, it will not form a satisfactory lubricating film for the sliding of the chip over the face or lip of the tool. It was not until some thirty odd years later that cutting pastes were put on the market and the first notable step forward was made in the use of an emulsifying material miscible with water.

There are three types of material used to make soluble emulsions:

1. One class of "soluble oils" is made from mineral oil compounded with a neutralized sulphonated oil; either from fixed or petroleum oils.
2. The second type of soluble oil is made from mineral oil compounded with an alcoholic solution of soap.
3. The third variant is marketed as a paste made from a thick soap solution and mineral oil.

Of the three forms of soluble emulsifiers, the last is least desirable. The second is made without expensive apparatus and requires less technical skill to fabricate. However, when petroleum sulphonates are used, these like the second type are easy to manufacture and are a safeguard against rusting iron and steel parts.

These emulsifiable oils are mixed with water, with one part of soluble oil for from 10 to 100 parts of water, for use as cutting fluids. They function primarily as coolants and wetting agents rather than lubricants. They also help wash away the chips and keep the material clean. Those soluble oil emulsions made with petroleum sulphonates prevent corrosion.

In general, emulsions of soluble oils are satisfactory for turning, milling, boring, drilling and sawing, and those operations employing relatively high speeds. A solution of soluble oil and water also is used for plain grinding since excessive oil will clog the pores of grinding wheels and causes them to skid instead of grind.

With the advent of cemented carbide tools permitting higher cutting speeds, soluble oils are looked upon with new favor. Not to be outdone, soluble cutting oils have gone to chemical additives to increase their scope and machining efficiency. Sulphur, chlorine, graphite and anti-foam agents are those used to prolong tool life, give better surface finish and do tougher jobs.

Although soluble oil mixtures are low-cost fluids and take an important part in cutting and grinding operations, nevertheless, it is not yet the universal cutting fluid that some users believe it to be. This is partly due to the fact that soluble oil emulsions interfere with proper lubrication of the bearings and spindles of certain automatic machines.

PLUGGING METHODS FOR MILL AND CRANE MOTORS

By E. J. POSSELT
Cutler-Hammer, Inc.

It is quite interesting to review the various methods being used for controlling plugging contactors on direct current, reversing plugging mill and crane controllers. Apparently each control manufacturer employs a different device and scheme to accomplish similar results. This paper summarizes the various devices and schemes used for plugging control.

A plugging controller is designed to connect the motor to the line in the reverse direction while the motor is still rotating in the forward direction. This may occur at any running speed, and the plugging contactor must be controlled to close as the motor speed decreases, to allow the next motor current peak at the proper time. On many applications, the plugging contactor is required to function with little variation, although other variables such as line voltage fluctuations, heating of resistors and coils, vibration, shock, etc. must be considered.

This paper describes factors to be considered in the design of plugging control equipment. On the basis of these factors and the various control schemes investigated, a method is described which provides the functions desired with a minimum number of control devices.

By using a plugging contactor which has a closing coil and a holdout coil, a separate plugging relay is not required. A dry type rectifier is connected in the motor armature reversing loop in combination with the plugging contactor holdout coil. The rectifier permits current to flow, energizing the holdout coil when the motor countervoltage is in one direction, but not in the other. The plugging contactor is thereby controlled so it can always close when the motor is started from rest, and it will protect the motor and load when the motor is plugged. The number of electrical interlocks required are reduced to a minimum.

A number of elementary diagrams are used for explaining how the rectifier plugging scheme works with one or a number of plugging contactors. Rectifier plugging control may be used for series, compound or shunt type motors. This scheme has been successfully employed on many crane controllers where consistent operation of the plugging contactor was an essential requirement.

GEARING FOR STEEL MILL AUXILIARIES AND CRANES

By L. J. COLLINS
General Electric Company

The primary purpose of this paper is to present certain facts pertaining to the choice of pressure angles in the design of gear teeth. Since the pressure angles most commonly employed are 14½ and 20 degrees, the subject matter will be restricted to a discussion of these two angles.

There are two schools of thought regarding the choice of pressure angle. Since this is the case, it must be agreed that these choices have been made as the result of study on the part of a number of individuals. The author of this paper is desirous of presenting the facts, as he sees them, which would logically lead to the choice of one or the other of the two angles under discussion.

The method of attack followed in preparing the paper is the same as would be employed by a designer faced with the problem of designing a gear train for a specific application. However, in order that the scope of the paper shall not be narrow, the reasons underlying the choice of any particular factor will be presented. Comparisons between the design decided upon and alternate designs are given.

An effort has been made to avoid the use of mathematical equations except where absolutely necessary. In every case where an equation has been used an effort has been made to present it as clearly as possible.

The individuals who are interested in this paper are of a very practical nature. Since this is the case, they are not as much interested in a purely theoretical gear train, as they are in one which can actually be designed and built. A gear as designed is theoretically perfect, and this condition may be approached during manufacture. However, in the interest of cost it is not always practical to manufacture a gear as perfectly as possible. The factory must be allowed certain tolerances in manufacture. The type and magnitude of these tolerances prevent the gear from being theoretically perfect. An effort has been made to compare the performance of a practical gear with that of a theoretically perfect one. Some idea of how the cost will increase as the theoretically perfect gear is approached is also given.

SCALE REMOVAL AND SURFACE PREPARATION OF METALLIC SURFACES BY REDUCTION WITH SODIUM HYDRIDE

By H. L. ALEXANDER
E. I. du Pont de Nemours & Company

The use of sodium hydride to remove mill and process scale as well as to prepare metallic surfaces for industrial operations is a recent and novel development in the steel industry.

Sodium hydride, a powerful reducing agent, reacts with metallic oxides, such as formed during hot rolling and annealing operations, welding and brazing flux, and sand, thereby expediting the cleaning of metal and alloy surfaces during prime production and fabrication into finished articles. The reducing action of this compound may be illustrated by the following chemical equation:

$$4\ NaH + Fe_3O_4 \longrightarrow 4\ NaOH + 3\ Fe$$

When the reducing reaction stops, there is no further action upon the base metal; consequently pitting does not occur. All metals and alloys which do not react with fused caustic soda and whose physical characteristics are not adversely changed by the 700 F operating temperature of the bath are amenable to treatment; some materials which react slowly may be treated if satisfactory results are obtainable with treatments of short duration.

A sodium hydride concentration of from 1.5 to 2 per cent is produced "in place" by reacting metallic sodium and hydrogen in open bottom chambers partially immersed in a fused carrier bath of anhydrous caustic soda. Dragout is usually made up by the caustic soda formed during the scale reducing reaction.

Sodium bricks weighing either 2½ or 5 pounds are fed at regular intervals (ranging from 15 to 60 minutes) to the generators into which hydrogen or dissociated anhydrous ammonia is introduced near the bottom at a rate adjusted to the sodium rate. Sodium hydride emerges from the generator and is diffused uniformly through the bath by the convection currents.

Work to be treated is placed in baskets or on racks and is introduced and held in the bath until the reducing action stops. The duration of treatment depends chiefly on the type and amount of scale present, usually ranging from a few seconds to 20 minutes.

After the treating cycle is completed, the work is removed from the bath, allowed to drain for a short period and then quenched in water. During the quenching operation most of the reduced scale is driven off, thus exposing the base metal. A subsequent dip of short duration in a suitable acid is used to produce a bright appearance. The acid treatment may or may not be necessary depending on subsequent treatment of the work. For example the acid dip can be eliminated when the work is cleaned prior to inspection or is later finished by machining or grinding.

In commercial use since 1941, the sodium hydride descaling process has applications in the production, fabrication and finishing of many steel products.

ANALYSIS OF CENTRALIZED LUBRICATING SYSTEMS FROM AN OPERATING STANDPOINT

By J. P. GRAVENSTRETER
Carnegie-Illinois Steel Corporation

Many operators and engineers are familiar with only a few of the centralized lubricating systems offered to industry today, with the result that many of the field engineered installations of this type equipment are not entirely satisfactory. It is the purpose of this paper to help the operator and engineer make a better selection of a centralized system by acquainting him with the various features of the many systems available.

The paper is divided into four general parts. Part one contains a discussion of the component parts of every centralized lubricating system, including a definition of a system and a statement of their function. A short history of the development of the dispensing valve which is the heart of the centralized lubricating system is also included in this first part.

A discussion of the design and operation of single-line terminating, two-line, two-line progressive and single-line progressive centralized lubricating systems is contained in the second part of the paper along with a definition of each type of system. Included in the discussion of each of the types of systems are illustrations showing the operation of the dispensing valve used by each supplier of that type of system.

The third part of the paper shows various features of design and operation of each of the nine systems described in part two in tabulation form. This tabulation will include such information as the number of valve sizes available with each system, discharge capacity of each valve, system operating pressure, method of cycling the system, number of pumping cycles required to lubricate all the points in the system, etc.

The final part of the paper contains several questions that should be asked when selecting a system, the answers to which more or less determine the type of system that should be used. There is also a short discussion of the common problems of lubricating system operation and some of their solutions.

(Additional abstracts follow immediately after program.)

A.I.S.E.

1946 ANNUAL CONVENTION and IRON AND STEEL EXPOSITION

PUBLIC AUDITORIUM, CLEVELAND, OHIO

October 1, 2, 3, and 4, 1946

It is with considerable pleasure that the Association of Iron and Steel Engineers again invites the men of the steel industry to the 1946 Annual Convention and Iron and Steel Exposition.

Bigger and better than ever before, the Exposition — the first since 1941 — will be bristling with the many developments of the past five years. The technical sessions have also been greatly amplified.

The Association is proud to offer this four-day program. Plan to come to Cleveland, to see, hear and take home ideas that will benefit you and your company.

Freeman H. Dyke

President
Association of Iron and Steel Engineers

Program .... CLEVELAND PUBLIC AUDITORIUM

Tuesday, October 1

Iron and Steel Exposition — 10:00 a.m.-10:00 p.m — Arena and Exhibition Hall

9:00 a.m. — REGISTRATION — Main Lobby

9:00 a.m. — LADIES REGISTRATION — Parlor M, Hotel Statler

9:15 a.m. — BUSINESS MEETING — Ball Room

Conducted by President F. H. Dyke

9:30 a.m. — ELECTRICAL SESSION — Ball Room

Chairmen:
F. W. Cramer, Carnegie-Illinois Steel Corporation
V. E. Schlossberg, Inland Steel Company

"Gearing for Steel Mill Auxiliaries and Cranes," by L. J. Collins, General Electric Company.

Discussion of Mill Type Motor Ratings, by Frank Cramer, Chairman, AISE Standardization Committee.

Standardization Committee Reports, by chairmen of various sub-committees.

2:00 p.m. — LADIES — Luncheon and Style Show, Lattice Room, Hotel Statler

2:00 p.m. — OPERATING PRACTICE SESSION — Ball Room

Chairmen:
C. L. McGranahan, Jones & Laughlin Steel Corporation
J. L. Tatman, Wheeling Steel Corporation

"Scale Removal and Surface Preparation of Metallic Surfaces by Reduction with Sodium Hydride," by H. L. Alexander, E. I. du Pont de Nemours & Company.

"Machinery for Roller Leveling Flat Rolled Material," by A. J. Wardle, Jr., McKay Machine Company.

"The Corrugating of Sheet Metal," by Joseph E. Kiefer, The Streine Tool and Manufacturing Company.

2:00 p.m. — COMBUSTION SESSION — Club Room B

Chairmen:
P. F. Kinyoun, Bethlehem Steel Company
E. C. Hite, Timken Roller Bearing Company

"Heating and Melting Furnace Controls," by C. G. Bigelow, Jr., Loftus Engineering Corporation.

"Economics of High Pressure Steam in Steel Mill Power Plants," by F. A. Sawyer, Stone and Webster Engineering Corporation.

"Heat Flow Problems in the Steel Industry," by Victor Paschkis, Columbia University.

10:00 p.m. — Exhibitors' Dance, Euclid Ball Room, Hotel Statler

Wednesday, October 2

Iron and Steel Exposition — 10:00 a.m.-10:00 p.m.

9:00 a.m. — SAFETY SESSION — Ball Room

Chairmen:
R. H. Ferguson, Republic Steel Corporation
James Farrington, Wheeling Steel Corporation

"Industrial Health Hazards in the Steel Industry," by J. William Fehnel, Metropolitan Life Insurance Company.

"Recommended Practice in Connection with Fire Prevention and Safety in By-Product and Benzol Plants," by R. W. Schirmer, Hendricks Engineering Corporation.

"Suggested Methods Which May Be Used to Prevent Accidents from Asphyxiation and Explosions of Various Types of Gases," by J. M. Lewis, Mine Safety Appliance Company.

11:45 a.m. — LADIES — Luncheon and Inspection Trip. Buses leave Hotel Statler at 12:00 noon.

12:15 p.m. — Old Timers' Luncheon, Lattice Room, Hotel Statler

2:00 p.m. — ELECTRICAL SESSION — Ball Room

Chairmen:
E. L. Anderson, Bethlehem Steel Company
M. B. Antrim, Lukens Steel Company

"Modern Trends in Brush Operation," by Leon D. Cook, Commonwealth Edison Company.

"Comparison of A-c and D-c Power Distribution," by G. A. Kaufman, Jones and Laughlin Steel Corporation.

"Spot Conversion for Adjustable Speed Drives," by R. A. Geuder and W. R. Hough, Reliance Electric and Engineering Company.

2:00 p.m. — COMBUSTION SESSION — Club Room B

Chairmen:
C. J. Wyrough, Jones & Laughlin Steel Corporation
H. S. Hall, Lukens Steel Company

"Submerged Combustion in Industry," by W. G. See, Submerged Combustion Company of America.

"Recent Improvements in Cover Annealing," by A. J. Fisher, Bethlehem Steel Company.

"A New Method of Strip Coil Annealing," by H. H. Armstrong and F. F. Schlitt, Lee Wilson Engineering Company, Inc.

Thursday, October 3

Iron and Steel Exposition — 10:00 a.m.-5:30 p.m.

9:00 a.m. — ELECTRICAL SESSION — Ball Room

Chairmen:
I. N. Tull, Republic Steel Corporation
A. D. Howry, Alan Wood Steel Company

"Electrical Equipment for the Sendzimir Precision Cold Strip Mill," by H. W. Poole, General Electric Company.
"Plugging Methods for Mill and Crane Motors," by E. J. Posselt, Cutler-Hammer, Inc.
"Power and Power Factor in Arc Furnace Operation," by Earle H. Browning, Westinghouse Electric Corporation.

9:00 a.m. — LUBRICATION SESSION — Club Room B

Chairmen:
C. E. Pritchard, Republic Steel Corporation
C. R. Hand, Bethlehem Steel Company

"Surface Activity of Lubricants," by J. M. Wilson, Shell Oil Company, Inc.
"Analysis of Centralized Lubricating Systems from an Operating Standpoint," by J. P. Gravenstreter, Carnegie-Illinois Steel Corporation.
"Rust Preventive Compounds," by H. Carpenter, Standard Oil Company of New Jersey.

2:00 p.m. — MECHANICAL SESSION — Ball Room

Chairmen:
L. J. Gould, Bethlehem Steel Company
T. R. Moxley, Wheeling Steel Corporation

"Automatic Welding in Steel Plant Maintenance," by H. E. Holman, Jones and Laughlin Steel Corporation.
"Storage Yard Material Handling," by Frank C. Wier, The Timken Roller Bearing Company.
"Scheduling of Maintenance Shops," by L. E. Fuller, Jr., Carnegie-Illinois Steel Corporation.

2:00 p.m. — COMBUSTION SESSION — Club Room B

Chairmen:
E. C. McDonald, Republic Steel Corporation
B. B. Bargman, Carnegie-Illinois Steel Corporation

"Improved Design of Metallic Recuperator," by Frank D. Hazen, Hazen Engineering Company.
"Refractories versus Combustion in Steel Mill Furnaces," by Edwin N. Hower, Carnegie-Illinois Steel Corporation.
"Heating Rate Tests of Slab Reheating Furnaces," by J. W. Percy, United States Steel Corporation.

7:30 p.m. — Formal Dinner-Dance, Grand Ball Room, Hotel Statler

Speaker: E. M. Richards, vice president in charge of operations, Republic Steel Corporation, Cleveland, Ohio.

Friday, October 4

Iron and Steel Exposition — 10:00 a.m.-4:00 p.m.

9:00 a.m. — OPERATING PRACTICE SESSION — Ball Room

Chairmen:
W. H. Collison, Great Lakes Steel Corporation
Frank Janecek, Republic Steel Corporation

"Iron Ore Reserves of the Mesabi Range," by E. W. Davis, University of Minnesota.
"The Chemical Removal of Scales, Sludges and Oxides from Blast Furnace Cooling Systems and Allied Steel Mill Equipment," by B. H. McDaniel, Dowell, Inc.
"The Manufacture of Oxygen in Large Quantities for Industrial Uses," by Martin J. Conway, Steel Industry Consultant, Stacey Dresser Engineering.

2:00 p.m. — ROLLING MILL SESSION — Ball Room

Chairmen:
Alex Montgomery, Jr., Carnegie-Illinois Steel Corporation
Louis Moses, Bethlehem Steel Company

"Modern Seamless Tube Mills," by William Rodder, The Aetna-Standard Engineering Company.
"The Use of Tension in Sizing Small Diameter Seamless Pipe and Tubing," by S. W. Stouffer, National Tube Company.
"Rod Mills and Rod Mill Roll Design," by Ross E. Beynon, Carnegie-Illinois Steel Corporation.

2:00 p.m. — LUBRICATION SESSION — Club Room B

Chairmen:
D. N. Evans, Inland Steel Company
R. A. Barta, Republic Steel Corporation

Symposium on Soluble Oils:
"Quenching and Processing," by Steven Smith, Air Reduction Sales Company.
"Cold Rolling Strip Steel," by R. W. Piper, R. W. Piper Company.
"Cutting and Grinding," by C. M. Larson, Sinclair Refining Company.
"Bacterial Deterioration," by L. Liberthson, L. Sonneborn Sons, Inc.

All of the events of the Convention and Exposition, with the exception of the social functions, will be held in the Cleveland Public Auditorium.

.....Don't Fail to Visit the

LIST OF EXHIBITORS

Company	Booth Number
A	
Air Reduction Sales Company	100, 101, 102, 103
Allen-Bradley Company	308, 309
Allis-Chalmers Manufacturing Company	33, 34, 35, 36, 37
Aluminum Company of America	262, 263
American Car and Foundry Company	321
Amsler-Morton Division, Union Industries, Inc.	317
Askania Regulator Company	57
Automatic Transportation Company	38, 39, 66, 67
B	
Bailey Meter Company	274, 275
Baker-Raulang Company, The	1, 2, 3
Bantam Bearings Division, The Torrington Company	318
Barrett-Cravens Company	248, 249
Bearing Service Company	320
Benjamin Electric Manufacturing Company	127
James G. Biddle Company	206
Blaw-Knox Company	276, 277
Charles Bruning Company, Inc.	314, 315, 316
Buckeye Laboratories Corporation	117, 118
Burndy Engineering Company, Inc.	138, 139
C	
The Carbone Corporation	273
Clark Controller Company, The	30, 31, 32
Cleveland Crane & Engineering Company	50, 51, 52, 53, 54, 55
Cleveland Worm & Gear Company, The	244, 245, 246
Crouse-Hinds Company	134
Cutler-Hammer, Inc.	46, 47, 58, 59
D	
De Laval Separator Company, The	344
Joseph Dixon Crucible Company	119
Dougherty Lumber Company, The	68, 69
Dravo Corporation	301
E	
Thomas A. Edison, Incorporated	110
Electric Controller & Manufacturing Company, The	328, 329, 330, 331
Electric Products Company, The	83, 84
Electric Service Manufacturing Company	271, 272
Electric Storage Battery Company, The	143
Electro Chemical Process Division, Blaw-Knox Company	276, 277
Elwell-Parker Electric Company, The	94, 95
Eutectic Welding Alloys Corporation	63, 64, 65
F	
Factory Stores Company	336,337
Farval Corporation, The	244, 245, 246
Federal Electric Products Company, Inc.	25, 26, 27
Forker Corporation	218, 219, 220, 221, 222, 223
Furnace Engineers, Inc.	284, 285

Iron and Steel Exposition

Company	Booth Number
G	
Garlock Packing Company, The	6, 7
General Allied Metals Company	327
General Electric Company, Bridgeport Division	147
General Electric Company	278, 279, 280, 281
Gordon Lubricator Division, Blaw-Knox Company	276, 277
Gould Storage Battery Company	24
H	
Heil Process Equipment Corporation	310
Hodson Corporation, The	259, 260
Holophane Company, Incorporated	48
Homestead Valve Manufacturing Company, Inc	264, 265
C. B. Hunt & Son, Inc	40, 41
Hyatt Bearings Division, General Motors Corporation	286, 287
Hydropress, Incorporated	352
I	
Ideal Industries, Incorporated	268, 269
International Nickel Company, Inc., The	236
Iron Age, The	348, 349
I-T-E Circuit Breaker Company	240, 241
J	
Jefferson Electric Company	253
K	
Kennametal, Incorporated	148
Keystone Lubricating Company	201
Koppers Company, Incorporated	306, 307
L	
Lewis Foundry and Machine Division, Blaw-Knox Company	276, 277
Lincoln Engineering Company	290, 291
Linde Air Products Company, The	80, 81, 82
Lintern Corporation, The	85
Lovejoy Flexible Coupling Company	23
M	
Markal Company	247
Mesta Machine Company	288, 289, 304, 305
Mine Safety Appliances Company	282, 283
Morganite Brush Company	202
D. J. Murray Manufacturing Company	252
N	
National Alloy Steel Division, Blaw-Knox Company	276, 277
National Carbon Company, Inc., Unit of Union Carbide & Carbon Corporation	78, 79
O	
Ohio Electric Manufacturing Company, The	237
Okonite Company, The	303
Otis Elevator Company	261
Owens-Corning Fiberglas Corporation	230, 231, 232
Pennsylvania Industrial Engineers Division, Union Industries, Inc.	317

LIST OF EXHIBITORS — CONTINUED

Company	Booth Number
P	
Penton Publishing Company, The	311, 312
Philco Corporation	96
Pittsburgh Rolls Division, Blaw-Knox Company	276, 277
Post-Glover Electric Company, The	77
Powermatic Ventilator Company	350, 351
Progressive Systems, Incorporated	8
Pyle-National Company, The	22
Pittsburgh Pipe Cleaner Company	70
R	
Ready-Power Company, The	4, 5
Reliance Electric & Engineering Company, The	44, 45, 60, 61, 76
Rockbestos Products Corporation	56
S	
Safety Clothing & Equipment Company	319
Salem Engineering Company	235
Shell Oil Company, Incorporated	353, 354
SKF Industries, Inc	71, 72
Socony-Vacuum Oil Company, Incorporated	266, 267
South Bend Lathe Works	9, 10
Speer Carbon Company	270
Square D Company	73, 74, 75
Steel Publications	254
Stewart-Warner Corporation	250, 251
Superior Carbon Products, Inc	302
T	
Texas Company, The	342, 343
Thomas & Betts Company, Inc., The	323, 324
Thompson Electric Company, The	42, 43
Thomson Industries, Incorporated	322
Tide Water Associated Oil Company	108, 109
Timken Roller Bearing Company, The	105, 106
Tool Steel Gear and Pinion Company, The	238, 239
Trabon Engineering Corporation	28, 29
Truflo Fan Company	62
Trumbull Electric Manufacturing Company, The	234
U	
Union Carbide and Carbon Corporation	78, 79, 80, 81, 82
Union Steel Castings Division, Blaw-Knox Company	276, 277
United Engineering and Foundry Company	144, 145
W	
Wagner Electric Corporation	203, 204, 205
Waldes Koh-I-Noor, Inc	224, 225
John Waldron Corporation	292
Wellman Engineering Company, The	233
Lee Wilson Engineering Company, Inc	255, 256
Y	
Yale & Towne Manufacturing Company, The	211, 212, 214, 215, 226, 227, 228, 229

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Iron & Steel Exposition

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ASSOCIATION OF IRON AND STEEL ENGINEERS

PUBLIC AUDITORIUM, CLEVELAND, OHIO

OCTOBER 1, 2, 3, and 4, 1946

The annual Iron and Steel Exposition which will be held in conjunction with the Annual Convention of this Society promises to be of considerable interest to all the steel mill executives and operating men. Approximately 150 manufacturers of steel mill equipment will utilize 30,000 square feet of space in the exhibit halls to display their latest designs of equipment. This year's Iron and Steel Exposition is the first to be held since the beginning of World War II. During the war years and the current reconversion period there have been rapid strides in the developments of new methods and new products. At the Exposition you will see for the first time all of the developments as they pertain to the iron and steel industry. Never before has it been so important to keep abreast of new developments. From advance information it can be truthfully said that this coming Iron and Steel Exposition will be one which few steel men can afford to miss.

EXPOSITION HOURS

Tuesday, October 1	**10:00 A.M. to 10:00 P.M.**
Wednesday, Oct. 2	**10:00 A.M. to 10:00 P.M.**
Thursday, Oct. 3	**10:00 A.M. to 5:30 P.M.**
Friday, Oct. 4	**10:00 A.M. to 4:00 P.M.**

INDUSTRIAL HEALTH HAZARDS IN THE STEEL INDUSTRY

By J. WILLIAM FEHNEL
Metropolitan Life Insurance Company

The steel industry has made great progress in cutting down its accident rate through a first aid and safety program. This program has been expanded so as to not only provide safe, but healthy, working conditions.

The industry has some potential health hazards associated with the various manufacturing processes. Dusts of a siliceous nature are encountered in foundries and the relining of furnaces. These are the two operations at which employees have developed silicosis. There are many types of inert dusts produced which are of a nuisance type, and which may set up a safety hazard, but do not affect the health of the workmen. Good housekeeping and safety practices call for the suppression and elimination of all types of dusts wherever possible.

Exposures to metal fumes and their effects are discussed for departments and operations where these fumes are dissipated into the workroom atmospheres. Exposures to radiant heat, dampness, and drafts are prevalent in the steel industry as reflected by disability claims.

The health hazards associated with maintenance and repair work are often overlooked. Some of these exposures are severe and often are undetected until an injury or disability results. The exposures of crane operators to health hazards in various departments are enumerated. Means of evaluating and correcting of health hazards are discussed. The importance of a good housekeeping program is stressed.

BACTERIAL DETERIORATION OF CUTTING OILS

By L. LIBERTHSON
L. Sonneborn Sons, Inc.

This paper deals with the relatively little explored phenomenon of the destabilizing action of certain bacterial organisms on cutting oil emulsions. The discussion is based on an actual case history which involved the loss of large volumes of stored emulsions due to a deteriorative process attributed to the presence of sulfur reducing bacteria.

Micro-biologists have long been familiar with the existence of bacteria which utilize sulfur in their metabolic cycle. Some of these organisms are of the sulfur reducing type and are capable of breaking down compounds containing combined sulfur, as manifested by the formation of hydrogen sulfide. Other types are capable of fixing and oxidizing the sulfur in a manner analogous to the action of the familiar nitrogen fixing bacteria.

In the case described in the paper, thousands of gallons of cutting oil emulsions were lost because they spoiled in storage; the emulsion turned black, emitting H_2S and finally splitting into the respective oil and water phases. It was postulated that the particular responsibile organisms were anaerobic in character. Accordingly, aeration of the emulsion was suggested as a means of rendering the medium hostile to the functioning of the bacteria. This measure was, in some cases, largely successful.

In the course of the investigation, it was shown possible to inoculate fresh emulsions simply by admixing small amounts of the deteriorated material. In view of the fact that aeration of large volumes of emulsion, running into thousands of gallons, was often impracticable due to lack of equipment, a number of specific inhibitors was indicated as providing a means for avoiding spoilage.

The particular object of the paper, is to provoke discussion, research and extension of the ideas set forth to problems in other fields, notably a field which is of enormous importance to metallurgists, to wit, corrosion of ferrous metals and alloys.

A brief survey of the literature on the subject of sulfur bacteria is presented, and such familiar phenomena are cited in illustration of the action of sulfur bacteria as the corrosion of sub-soil pipe lines, gas holders and similar structures. The possible role of the bacteria under discussion is suggested in connection with frequent failures of commercial rust inhibiting compounds and so-called preservative oils which were specified and used in huge volumes by the Army, Navy and Ordnance Departments.

For industrial establishments, in which cutting oil emulsions are stored in large quantities, as in cases where such emulsions are piped through the circulating system over relatively large working areas, it is urged that absolute cleanliness and sterility are probably the best guarantee against infection. Where, however, the latter does take place and aeration is not practical, the use of specific inhibitors is suggested, such as of highly oxygenated and oxygen evolving compounds, e.g. sodium perborate.

More recently, and subsequent to the publication of the paper, other categories of agents exerting an antibiotic effect against sulfur bacteria were investigated, including organic and inorganic hypochlorites, organic mercury compounds including soaps such as nephthenates, phenolic and polychlorinated aromatic compounds.

The general indication of the paper is that the industrial microbiologist has a provocative subject for extensive research in this field, particularly in view of the fact that under industrial conditions, what is most likely operative, is not so much a single bacterial agent, but a number of them functioning symbiotically in environments in which possibly the hydrocarbons in petroleum oils themselves provide a favorable factor, since the latter are in themselves subject to the action of specific bacteria which decompose them to water and CO_2, the latter, in turn, contributing to the anaerobic condition which is favorable to the functioning of sulfur reducing bacteria.

While the entire subject is highly complex, it is hoped that further research in this direction may develop in the near future.

ECONOMICS OF HIGH PRESSURE STEAM IN STEEL MILL POWER PLANTS

By F. A. SAWYER
Stone and Webster Engineering Corporation

It is the purpose of the paper to discuss the economic advantages of applications in existing steel plants of steam-electric power generating plants for operation at pressures and temperatures as high as are found in the most efficient public utilities and in the most modern steel mill power plants.

A brief review of the historical background of the steel industry is made to indicate its trend of progress.

The desirability of high pressure steam operation in a steel mill power plant is investigated by an analysis of operating economies of actual and theoretical steam electric generating stations based on a study of plant heat rates and fuel rates in relation to pressures and temperatures of operation. Installation and maintenance costs are not considered as being within the scope of the paper.

The important factors in the operation of steel mill power plants, fuel supply, electric loads and character of loads, are given prime consideration in the arguments for and against the higher pressure and temperature steam conditions.

Tables, curves and descriptive information of operating conditions of actual and theoretical power plants, support the analysis.

In conclusion, the major problems confronted in the design of steel mill power plants are reviewed with an eye to indexing the factors likely to determine the desirability of higher pressure and temperature steam conditions for specific steel mill power plant installations.

HEAT FLOW PROBLEMS IN THE STEEL INDUSTRY

By VICTOR PASCHKIS
Columbia University

In many instances, heat problems are associated in the minds of steel engineers with problems of fuel economy and problems of combustion. However, there is a wide field of heat flow problems which does not properly belong in this classification, which is frequently overlooked and which deserves full attention. On the solution of these problems depends, in many instances, quality and quantity output.

This paper does not propose to give a complete list of heat problems, but rather discusses a selected number of problems. These problems include open hearth furnaces, arc furnaces and induction furnaces; they include problems of ingot solidification, of the soaking pit process, and of heating for rolling including the subsequent cooling, and of heat treating.

By way of example, for open hearth furnaces the regenerator problem is discussed as well as the problem of heat transfer within the charge. In ingot solidification the problems of solidification time and of ingot-mold ratio are explained. For reheating, the problem of uniformity in its relationship to heating times is mentioned.

Listing the problems without an indication as to how they can be solved would not be significant. A mathematical solution of the problems is in most cases impractical; the solutions are not known, and if available would be too lengthy for steel mill use. A relatively new method of solving such problems is described as the electric analogy method and exemplified in the heat and mass flow analyzer. The method is briefly described and some successful applications of interest to steel mills are mentioned.

RECENT IMPROVEMENTS IN COVER ANNEALING

By A. J. FISHER
Bethlehem Steel Company

This paper covers the recent improvements made in the sheet and tin plate annealing departments of the Bethlehem Steel Company at Sparrows Point, Maryland. The paper is divided into the following headings:

A. Direct fired covers
   1. Method of operation
   2. Fuel consumption
   3. Tons per hour
   4. Maintenance
B. Coil convection and flat sheet bases
   1. Method of operation
   2. Maintenance
   3. Kinds of inner cover seals
C. Inner cover protective coatings
   1. Design
   2. Kinds of coatings
   3. Maintenance
D Instrumentation
   1. Thermocouples
   2. Instruments
   3. Controls
E Prepared atmospheres
   1. Central station atmosphere gas plant
   2. Carbon edges
   3. Shadow edges
   4. Corrosion resistance

RECOMMENDED PRACTICE IN CONNECTION WITH FIRE PREVENTION AND SAFETY IN BY-PRODUCTS AND BENZOL PLANTS

By R. W. SCHIRMER
Hendricks Engineering Corporation

By-product and benzol plants are considered extremely hazardous from a fire and safety to life standpoint. Past experience and loss records prove the accuracy of this statement. Methods of safe installation and operational practices present a serious problem as well as do the effective means of combating and extinguishing any possible fires occurring in these plants. The subject should therefore be approached from the following angles:

1. Proper, safe installation of all equipment with all possible precautions being taken for the prevention of fires.
2. Inauguration of all known safe practices in operations so as not to defeat the purpose of preventive measures incorporated in the construction of the plant and equipment.
3. Provision of adequate fire fighting equipment of the type suitable for hazards involved and the maintenance of an efficient properly trained private fire fighting brigade within the plant.

The following further suggestions should be considered in constructing a new plant and incorporating the best known fire prevention and safety measures and practices in that plant. The application of these measures in existing plants will naturally be tempered by actual physical conditions and availability of funds necessary for making the changes required.

1. Proper safe installation of all equipment with all possible precautions being taken for the prevention of fires.
2. Plants should not be located in congested areas, and adequate area should be provided within plant to allow reasonable safe distances between buildings, scrubbers, agitators, tanks, loading racks, etc.
3. Buildings, equipment, tanks, etc., should all be properly grounded.
4. Railroad tracks entering plant area should be insulated from tracks outside of plant area and all tracks inside plant area should be properly bonded and grounded.
5. All lighting inside of buildings should be of the approved explosion proof type, all lighting outside of buildings in plant area should be of the approved vapor proof type.
6. Storage tanks should be enclosed in diked areas, tanks to be separated by individual dikes depending upon capacity and classification of liquid stored in tank.
7. Tanks should be properly vented with protected vents of proper size.
8. No open pipe trenches should be permitted, piping should be overhead or buried. All pipe connections to tanks should be at top of tanks where possible.
9. Inauguration of all known safe practices in operations so as not to defeat the purpose of preventive measures incorporated in the construction of the plant and equipment.
10. Carrying of matches or smoking materials inside plant area should be prohibited. Smoking should be prohibited.
11. Rigid rules for grounding portable equipment, tank cars, etc., should be enforced.
12. Non-sparking type tools only should be used.
13. All vents on tanks should be examined weekly for signs of corrosion and necessary repairs or replacements made immediately.
14. Coal fired locomotives should not be permitted in plant area.
15. Excellent housekeeping practices should be enforced at all times.
16. Provision of adequate fire fighting equipment of the type suitable for hazards involved and the maintenance of an efficient, properly trained, private fire fighting brigade within the plant.
17. Yard main and hydrant system of adequate size, capacity and pressure should be provided, hydrants to be 50 ft from buildings and spaced at about 400 ft intervals. Ample supply of well maintained fire hose must be provided.
18. Permanent installed approved foam extinguishing equipment and carbon dioxide equipment should be provided. Water fog may be used to protect specific hazards.
19. Ample portable first aid foam, carbon dioxide and carbon tetrachloride equipment should be provided.
20. Fire alarm, connected to audible sirens and to plant protection office, should be installed. Private fire brigade, properly instructed and drilled at monthly intervals, under supervision of a competent Plant Fire Marshal, should be maintained. Definite specific instructions as to calling public fire department should be posted and should be clearly understood by all members of brigade and plant protection officers.

SPOT CONVERSION FOR ADJUSTABLE SPEED DRIVES

By R. A. GEUDER and W. R. HOUGH
Reliance Electric and Engineering Company

Adjustable speed control can contribute markedly to economical production, particularly where the process concerns a wide range of products or gauges of products, such as, for example, the rolling of different thicknesses of steel strip. In addition, even when the process requires constant speed, adjustable speed is required for smooth acceleration and deceleration. No method for securing adjustable speed from an a-c source approaches the flexibility, simplicity, and economy of the variable voltage method. The basic principle employed is to use spot conversion from the a-c distribution system with variable voltage direct current control, commonly known as the Ward-Leonard system. The basic elements of the system are, a unit to convert a-c to d-c, a source of excitation which can be controlled to obtain a variable d-c voltage, a d-c motor receiving power from the conversion unit, and suitable control for starting, stopping and controlling the speed of the motor. In its simplest form, a useful speed range of ten to one is readily obtainable, and this range can be increased to twenty to one or even thirty to one with IR drop compensation.

Another characteristic of variable voltage is that it provides for approximate synchronization over the range of voltage control, when several motors are used on a machine.

The variable voltage system may be amplified to include controlled characteristics of various degrees and types. These fall basically into four classifications, control of current, voltage, speed, and rate of change of speed. Rotating type regulators are used largely in the precise control of these elements.

The variable voltage system can be applied to many

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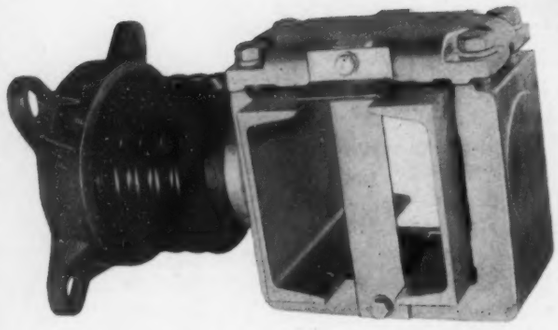

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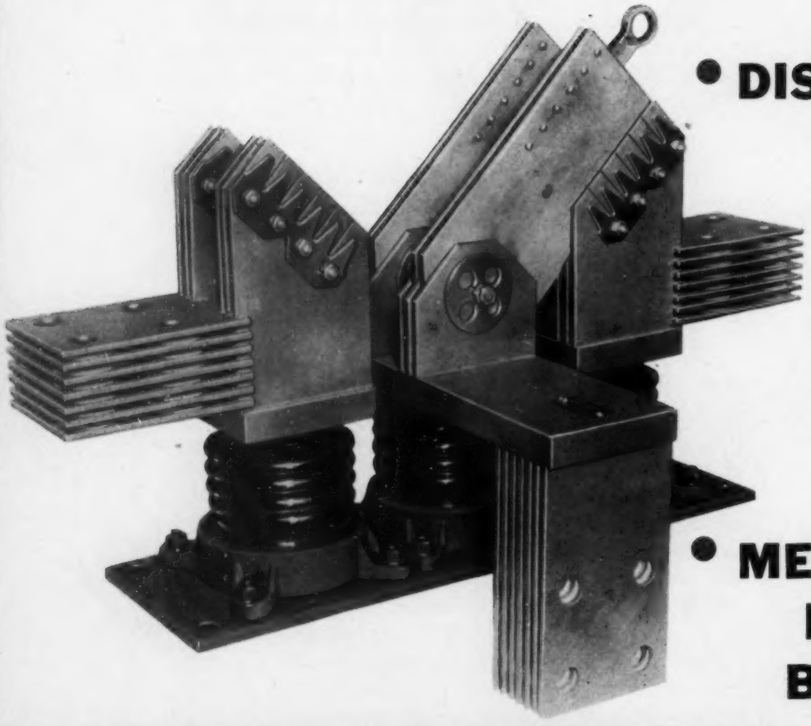

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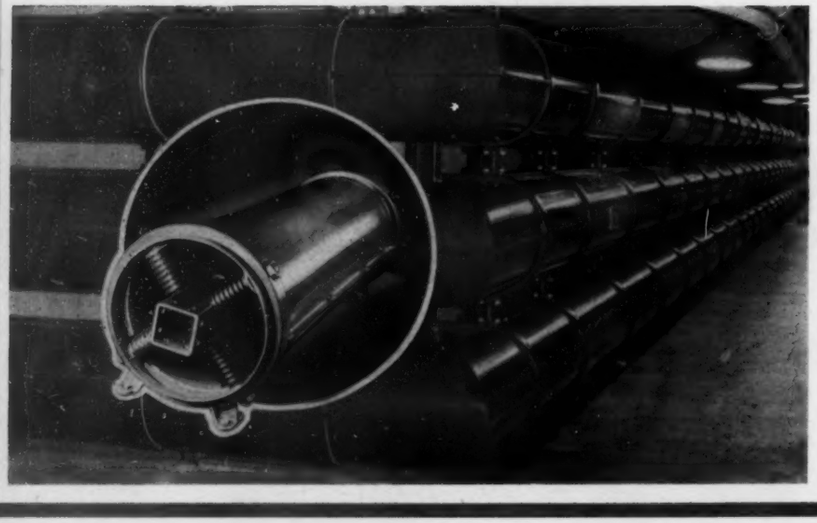

have sealed individual housings that prevent interphase short circuit. Support rings, as shown in circle, equalize all stresses. Covers can be removed for inspection or alterations. Especially suitable for heavy bus runs where mill dust and contamination is a problem.

Conductor can be round, square or bar.

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OPEN OR ENCLOSED ISOLATED PHASE HEAVY DUTY BUSES

KIRK INTERLOCK SYSTEMS

AUTOMATIC SWITCHING EQUIPMENT

METAL CUBICLES

TESTING DEVICES

systems other than the larger and better known applications of hot strip and cold reduction mills. These other applications include multi-motor wire blocks, blast furnace skip hoists, sintering plants, slitting, trimming, and processing lines, electroplating lines, and roll grinders. In many applications, gears may be eliminated.

To conclude, it is scarcely a question any longer whether a plant can afford variable voltage control, but whether it can afford to be without it.

DISCUSSION OF MILL TYPE MOTOR RATINGS

By FRANK W. CRAMER

Chairman of the A. I. S. E. Standardization Committee

The development by one of the largest electrical manufacturers of a new line of mill motors, in which the next higher horsepower rating is put in a frame one size smaller than previous, has brought up again the question of the proper motor rating which should be used in steel mill design. In order to determine the desire of the AISE, a questionnaire was sent to various electrical superintendents, designers and users of mill motors, asking their opinions on five pertinent questions. The questions are:

1. Should physical dimensions of mill motors as listed in the AISE standards be retained?
2. Do the present ten frame sizes cover your requirements?
3. Each of these frames now have five different ratings, are these all necessary? What ratings do you use in applying motors in auxiliary mill drives?
4. Do you believe that 75 degree C temperature rise is the desirable maximum? Do you feel that improved insulation, etc., will permit raising this?
5. Assuming that increased horsepower is put into the present frames, should speeds be held at present standards for the same horsepower or for the same frame sizes?

The paper discusses the answers received to the above questions. The following is a brief summary of some of the answers, although this abstract cannot cover the various stipulations and qualifications. However, in general the majority felt that the present AISE standard physical dimensions should be retained. The majority felt that the present frame sizes covered their requirements, although some felt that additional sizes would be desirable. About one-third of the people questioned said that they would be satisfied with only two motor ratings, a one-half and a one hour rating. About two-thirds favored the 75 C limit rise. No clear cut trend could be determined for the answer of the fifth question, due to the fact that it was variously interpreted.

ROLL OIL EMULSIONS FOR COLD ROLLING STRIP STEEL

By R. W. PIPER
R. W. Piper Company

This article deals with the various factors which affect the use and performance of roll oil emulsions in the cold reduction of strip steel. These factors include the condition of the strip surface being rolled, the water used in making the emulsion, the type of equipment used, etc. Many types of emulsions have been used for cold rolling, and the paper discusses these, and suggests care of same under operating conditions. Some comparisons are offered between results from cold reduction with roll oil emulsion and with palm oil in a number of selected applications.

HEATING AND MELTING FURNACE CONTROLS

By C. G. BIGELOW, JR.
Loftus Engineering Corporation

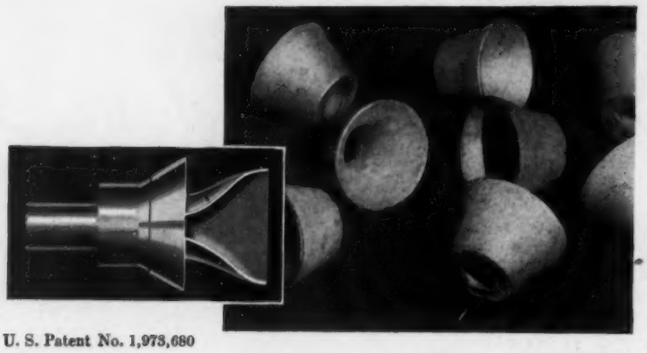
Most people take furnace instruments and controls pretty much for granted, never giving a second thought to the problems behind the scenes. These problems divide themselves readily into four groups: engineering decisions, actual selection, installation, and operation.

The engineering decisions include a critical analysis of the economic situation to determine that the investment in instruments pays for itself in the amortization period and brings profits to the company.

These considerations must include on one side, a multitude of cost factors among which, in addition to the cost of the instruments themselves, are: the cost of engineering; the cost of auxiliary apparatus such as valves, drive mechanism, and panels; the cost of installation labor and supervision; the cost of maintenance, labor, and spare parts; the operating costs such as electricity, oil or mercury, air supply, and chart paper and ink; the cost of collecting, integrating, and interpreting the records taken; the cost of teaching the operator; the cost of down time due to instruments; the cost of the orifice loss such as might arise in the case of a large high temperature fan; or the cost of obtaining that additional straight pipe necessary; the cost of union resistance; and possibly the cost of the space occupied by the panel board.

Also, the engineering consideration must include on the other side the fewer but higher valued savings factors likely, among which are: fuel economy, improved product, increased product, saving of labor, increased furnace life, and a check on the operators.

The selection of the instruments themselves must include the consideration of the main groups: temperature, pressure, flow, ratio, and program; the type of control impulse transmission such as electrical, pneumatic, hydraulic, or mechanical; the make of equipment best suited to the job; the degree of refinement necessary such as two-position, throttling, and manual or automatic reset; the style of instruments such as indicating only, indicating and controlling, or indicating and



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However, there are additional advantages — service life 22 to 24 times that of ordinary iron bells; self-cleaning, do not pick up scale; strong, sounder welds; and better looking pipe.

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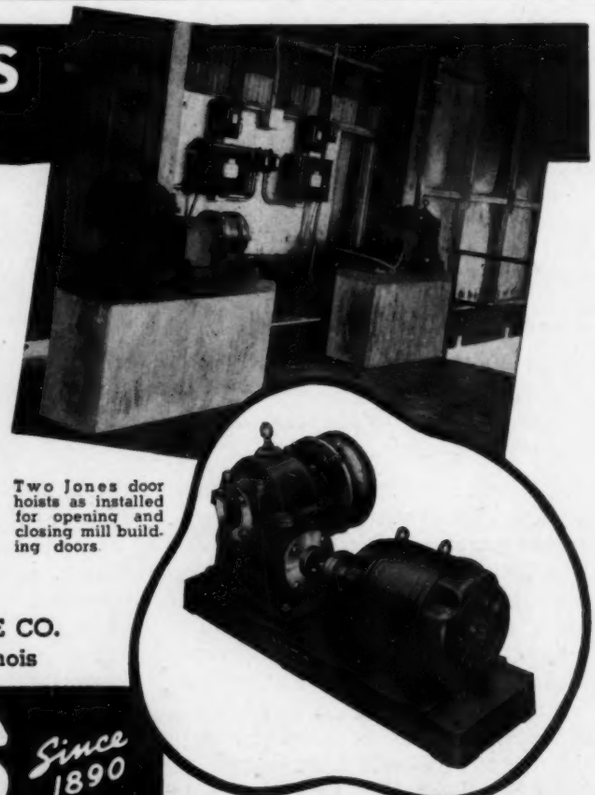
integrating recording controller complete with telemetering; and, by all means, the safety of the equipment.

For proper installation, these factors are among those that must be included: a good location of the sensing element, a suitable location of the control element, satisfactory operation of the controlled element, proper electrical supply and protection, proper air pressure and supply, clean hydraulic oil — and in the same vein — clean pipes, unobstructed impulse lines and pulsation dampening if desirable, and above all, proper following of the basic installation diagram.

Good operation should not be difficult nor the equipment short-lived if it is installed properly, as many abuses are accidental violence. Nevertheless, the instrument must be kept clean and lubricated, the charts changed, the pen filled, the batteries renewed, the standard cell protected, thermocouples inspected, the orifice plates cleaned, and calibration checked.

In view of our consideration of these things, it is concluded that it is desirable to equip our furnaces with meters and controls; that small, simple furnaces can use elementary indicators or controllers; that complete use is sometimes not made of recorders; that furnaces producing heat treated products make good use of automatic control; that more highly developed forms of instruments are required the more components there are involved in the control scheme; and that small shops must expect to add an instrument man when they start acquiring furnaces with control systems.

JONES DOOR HOISTS
for handling furnace doors



● Here is a simple, compact and sturdy heavy duty worm gear driven door hoist that has been widely used in the steel industry for handling furnace doors. It is also applicable to other services where doors of various types must be opened and closed and where it is desired to avoid the complications of limit switches.

With the Jones door hoist there is not the slightest hazard created by the possibility of over-travel. When the door is opened, if the motor is not stopped, a bronze ring on the winding drum slips and no damage can result . . . When the door is closed, the bronze ring again slips until the motor is stopped.

Thus the Jones door hoist automatically prevents over-winding and eliminates the necessity for expensive limit switches, brakes, or other electrical apparatus designed to prevent over-winding that might be dangerous or damage the equipment. Consequently this drive is simple, economical and fool-proof in its operation.

These door hoists are built by Jones as complete units with motor included if desired, or with base to take standard motor, as supplied by the purchaser.

If you have a door handling problem, our engineering department will be pleased to make a recommendation covering a unit that will handle it.

Two Jones door hoists as installed for opening and closing mill building doors.

W. A. JONES FOUNDRY & MACHINE CO.
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Jones door hoists are built in several ratings and may be installed in almost any convenient arrangement of sheaves and cables. Base will take any standard motor. NO LIMIT SWITCHES OF ANY KIND REQUIRED WITH THIS UNIT.

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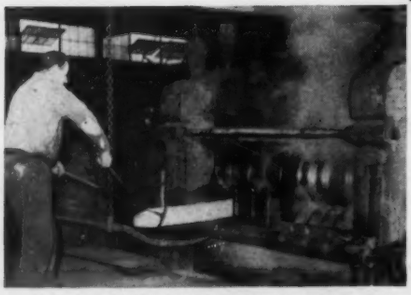

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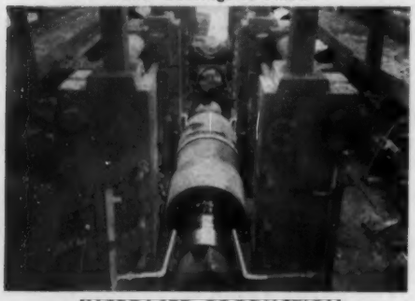

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Iron AND Steel ENGINEER

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WORLD'S FIRST CONTINUOUS SEAMLESS PIPE MILL TO BE BUILT BY NATIONAL TUBE AT LORAIN

▲ Developed by National Tube Company engineers, the world's first continuous seamless pipe mill is scheduled for installation at the Lorain, Ohio, plant of this United States Steel subsidiary.

Long identified with hot rolled strip and sheet mills, the continuous rolling process will be employed for the first time at Lorain to turn out long lengths of steel pipe without welds as fast as 2000 feet per minute.

The new process eliminates several steps in the conventional method of making seamless pipe. In standard practice, a solid round steel bar, heated white hot, undergoes five separate operations to be transformed into pipe. Lorain innovation combines most of these into one step.

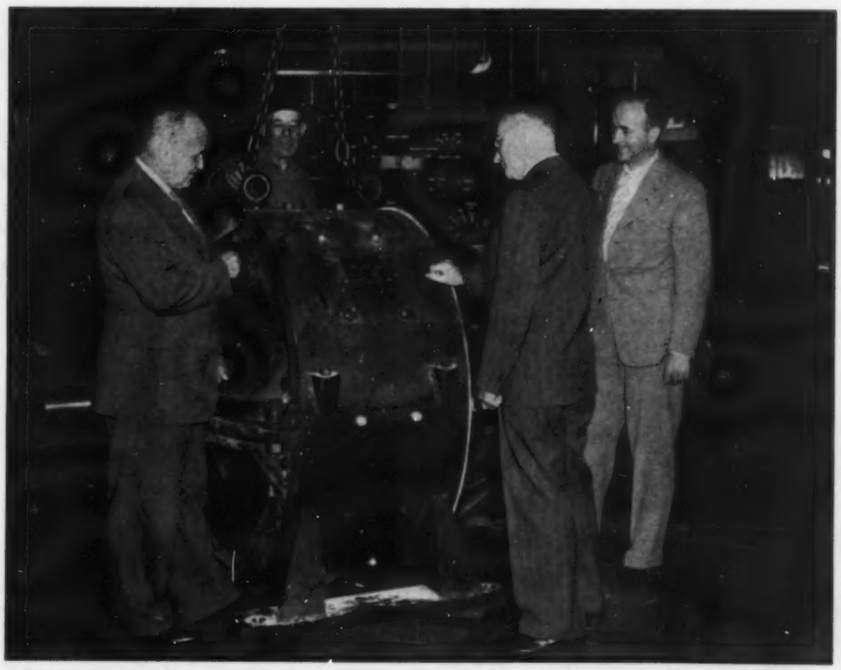
The conventional method starts with the first piercing operation in which an opening is formed lengthwise through the solid bar. Then comes the second piercer, in which the opening is enlarged; the high mill, which produces a uniform wall thickness in the pipe; reeling, to attain perfection in the pipe's surfaces; and finally the sizing rolls, where the product attains its desired diameter and length.

In the continuous seamless mill, the innovation comes after the first piercing operation, which remains unchanged. After the first piercing, the shell is processed through a nine-stand continuous rolling mill, which accomplishes the same results as several steps in present practice.

The conventional seamless mill moves its product sidewise down through the several operations. The continuous mill will operate as a straight-line production unit.

The new Lorain mill is designed to make small-size seamless products which are essential to housing and other construction work, ranging from two-inch boiler tubes to 4½-inch standard pipe.

140,000 TYPE "T" MOTOR BUILT BY RELIANCE



The 140,000th Type T motor to be built by the Reliance Electric and Engineering Company, this 300 hp "offspring" of a long line lacked only its final coat of paint when inspected one day last week by company officials. President J. W. Corey (left) and A. M. MacCutcheon, who recently retired as senior vice president, worked together on the original development of the motor back in 1914.

In the 32 years since then, Reliance has produced millions of horsepower in these heavy-duty d-c motors for the steel and other major industries.

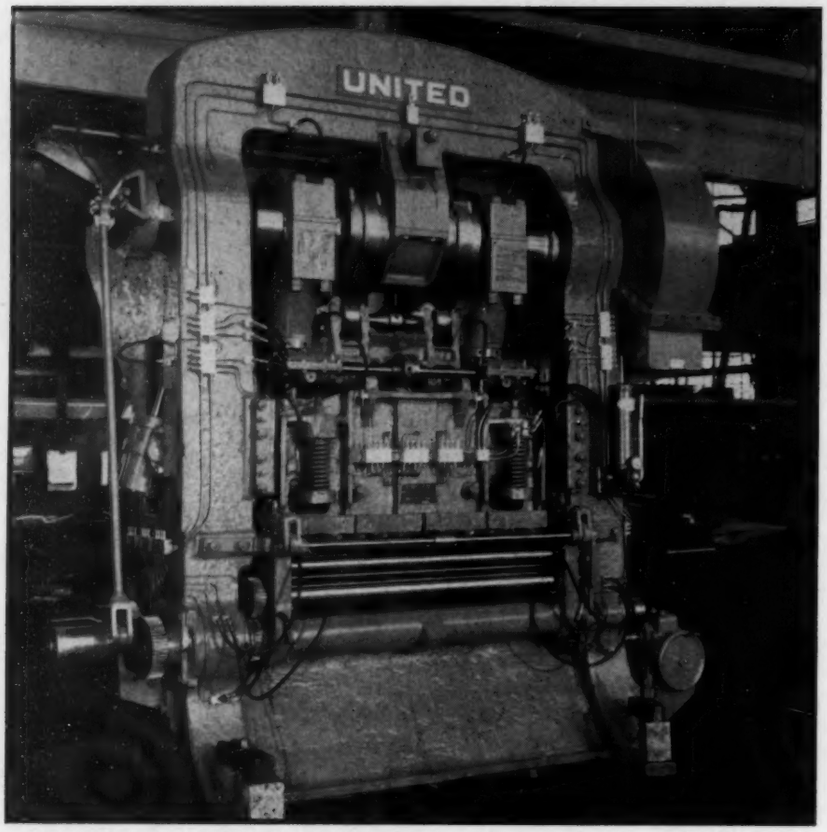
——E-55——

NEW PERFORATING PRESS FOR WICKWIRE-SPENCER

▲ United Engineering and Foundry Company has recently made delivery of a 250 ton mechanical sheet perforating press for the Wickwire Spencer Steel Division of the Colorado Fuel and Iron Company at Clinton, Massachusetts, designed to increase the efficiency of this company's perforating department.

The press is arranged to punch out a wide variety of perforations one-eighth of an inch to one and one-half inches in diameter in sheets up to 55 inches wide and also special shape and grillwork punching, the number of holes of a given size being proportional to the thickness and physical characteristics of the material to be perforated.

The punch is motor crank operated through entirely enclosed drive with d-c Ward-Leonard control to give speeds of 30 to 120 strokes per minute. The motor is provided with a start and stop single stroke, continuous



The mechanical sheet perforating press is arranged to punch out a wide variety of perforations ⅛ to 1½ in. in diameter in sheets up to 55 in. wide.

running and inching control for adjudtment of the punches and dies.

The material is fed into and out of the press by pinch rolls located on the entry and delivery sides actuated by an inching clutch and variable stroke crank to give a variable feeding stroke of 0 in. to 3 in. This feeding mechanism is mechanically synchronized with the operation of the punch.

Rigid all-steel construction, compact design, accessibility for changing dies, centralized lubrication are em bodied in this latest addition to United's line of manufacture.

——E-56——

GAS CARBURIZING FURNACE WITH 1800 F TEMPERATURE

▲ A new line of electrically heated, cylindrical, gas carburizing furnaces with maximum temperatures of 1800 F has been announced by the industrial heating division of the General Electrical Company. Featuring rapid and uniform distribution of carburizing gas throughout the charge through the use of a fan located on the furnace cover, the new furnaces are suitable for carburizing such parts as gears, splines, pins, and bearing races.

There are three furnaces in the new line, rated at 59.5 kw, 77.5 kw, and 110 kw. Loading baskets in the three sizes are 20 in. in diameter by 24 in. deep, 20 in. by 36 in., and 25 in. by 36 in. respectively. The furnace cover is lifted hydraulically, and guides are provided which prevent it from being lowered unless it is in proper position for sealing with the retort in the furnace. A 1½-hp fan is used on all three sizes. The fan motor is readily accessible for maintenance and inspection since it is mounted on the furnace cover.

Tanked propane or natural gas is admitted to the furnace retort as the carburizing medium. The flow of gas is regulated by a needle valve and a visual flow meter which are mounted on the operator's control panel. Also located on the panel are an automatic temperature control instrument and a strip chart temperature recording instrument for recording the temperature of the circulating atmosphere and charge of steel.

——E-57——

FIVE TON BATTERY IS LARGEST BUILT FOR TRUCKS

▲ Built to power the new 30,000 lb electric industrial ram trucks, the Electric Storage Battery Company announces a new "Exide-Ironclad" battery weighing five tons and having a capacity of 1500 ampere-hours. This battery, designated as the "MEH-31," is said to be the largest storage battery ever built for the operation of electric industrial trucks.

The new battery-powered ram trucks are designed to handle fifteen ton loads of coiled steel, and when delivered will be used in the tin plate mills of several of the largest steel plants in the country. This tonnage represents twice the load capacity of the largest ram trucks now used in the steel industry. Despite the 100 per cent increase in the capacity of these new rams, however, they require only 50 per cent more battery capacity to keep them in full-shift operation. The factors of high-availability and dependability of storage batteries as a source of motive power were among the important considerations leading to their selection for the operation of these new-giant materials handling trucks.

——E-58——

ROLLING MILL TO BE BUILT IN FAR EAST

▲ The Loewy Construction Company, Inc., New York has been awarded a contract for building an extensive rolling mill installation for sheet metal in the far east.

——E-59——

STEAM CLEANING UNIT FOR INDUSTRIAL USE

▲ A new postwar, streamline design steam cleaning machine known as "Model JO Hypressure Jenny" instantaneous steam cleaner has been announced by Homestead Valve Manufacturing Company.

This steam cleaner is a compact, portable, streamlined, steel-fabricated,

electric-welded unit with all machinery end-mounted and fully accessible. It can be furnished with or without a removable, die-formed steel machinery cover. Large, semi-steel wheels and a steering tongue afford easy portability and maximum utility permitting easy transfer from one cleaning job to another. Oil or gas fired units are optional, and the only requirements for operation are an electric current outlet and a hose connection to water supply.

"Hypressure Jenny" is recommended for all types of industrial applications. Cleaning is accomplished by a highly atomized mixture of steam, hot water and cleaning compound applied under pressure through a spray nozzle. Normal operating pressures range from 80 to 120 lb at 90 gph water capacity. Where powerful flushing and rinsing action and extra water capacity are required, the use of the "Adjusta-Blast" gun is recommended, which increases water capacity up to 480 gph.

——E-60——

1556 TRANSPORTER TRUCKS OPERATING IN 541 PLANTS

▲ A total of 1556 Transporter motorized hand trucks have been installed by 444 leading metal products and refining companies and are now at work in 541 plants operated by these firms, according to Automatic Transportation Company, manufacturers of the Transporter and other electric propelled material handling equipment.

Confirming the ever-increasing importance of modern material handling methods to industry at large, the company lists in a book just issued the 1579 outstanding companies in 12 principal industries — and in 1971 plants these firms are using 5767 Transporters, more than half the total now in service. All Transporter installations have been made during the last four and one-half years.

Included are automotive and aviation, ceramics, chemical, food, lumber and wood, machinery and equipment, metal products and refining, paper and printing, railroads and miscellaneous transportation, textile, and rubber and similar process industries. A manufacturer of electrical equipment is the largest single user, with 179 Transporters in 19 factories.

——E-61——

Mathews Methods *are paying*

DIVIDENDS

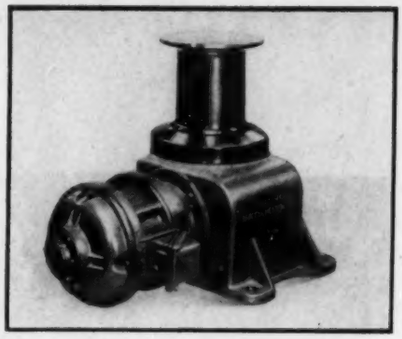
THE outstanding efficiency of manufacturers applying continuous flow handling methods provides proof that these methods are rendering real production service. Gravity and power conveyers and specially engineered conveying machinery usually are combined to make up Mathews Conveyer Systems. Such systems are an investment in greater output, lower costs, and improved employer-employee relations. The conveying equipment provides a steady flow of materials through processing machinery, and reduces manual handling and worker fatigue to a very minimum. It is designed to operate under severe service with very little maintenance attention, and into every section goes the finest of materials and manufacturing skill.

Mathews Engineers have acquired a wealth of experience in dealing with materials-handling problems. The benefit of this experience is readily available to you. Write or wire for field engineering service.

MATHEWS CONVEYER COMPANY
ELLWOOD CITY, PENNSYLVANIA
SAN FRANCISCO, CAL. • PORT HOPE, ONT.
ENGINEERING OFFICES IN PRINCIPAL CITIES

CAPSTAN CAR PULLER HAS INTEGRAL GEARING

▲ The Silent Hoist and Crane Company, pioneer manufacturers of worm-drive hoisting machinery, are now offering a new model electric capstan car puller in which the gearing is integral with motor, compact, totally enclosed, making the unit dirtproof, waterproof, and ideal for out-of-door use in all sorts of weather. The enclosed worm-gear reduction runs in a continual bath of oil.



This new car puller has gearing integral with motor.

The new "Silent Hoist" electric capstan car puller is available in two sizes, a 7½ horse-power unit with a capacity of 5000 lb draw-bar pull and a 15 horse-power unit with 10,000 lb draw-bar pulling capacity, all completely assembled ready to be bolted down to the user's foundation, designed for immediate service. Stock units are available for 220/440 volts, 3 phase, 60 cycles, and also for d-c service on application. Car pullers can be furnished with control and other accessories such as rope, car hooks, and snatch blocks. The new electric capstan car puller is available from stock, and because of standardization and mass production the price is attractively leveled.

——E-62——

SLAB HEATING FURNACE FOR SPARROWS POINT

▲ A contract to design and construct three continuous triple-fired slab heating furnaces for the Bethlehem Steel Company has been awarded the Rust Furnace Company. They will cost in excess of $750,000.

The furnaces, which are to be built for the new 66 inch strip mill at Bethlehem's Sparrows Point, Maryland, plant, are the second to be constructed there by Rust. Earlier, Rust Furnace Company designed and constructed the furnaces for the large strip mill at Sparrows Point.

The new units will have an effective heating length of 90 feet with an inside width of 24 ft 6 inches. Each furnace will have a capacity of 110 tons of steel an hour heated from cold to the rolling temperature of 2250 F.

——E-63——

LOW RANGE TESTER FOR RAW MATERIALS

▲ Because of the wide-spread growth of physical testing of raw materials and finished production items, the W. C. Dillon and Company, Inc., has developed the low-range tester. As its name implies, it is expressly built for lighter materials or small finished items. It has four separate capacities incorporated, each available instant-

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Insert numbers below corresponding to those of the *News Supplement* items in which you are interested in receiving detailed data.

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Included in this section is a coupon which can be used by you in obtaining additional information on any article that appears in the News Supplement. At the close of each item, on which information is obtainable, appears a key reference number (Example: E12 or NEB56). Simply mark the reference number on the coupon, complete your address data and return to us.

ly, and shown individually on its large dial. These ranges are: 0-10 pounds in 1 ounce dial divisions, 0-25 pounds in 2 ounces, 0-50 pounds in 4 ounces, and 0-100 pounds in 8 ounces.

Its lower grip travel is continuously variable, or stepless, from 0 to 19 in. per minute. It also has: ½ of 1 per cent accuracy, pendulum action, max-load reading, featherweight and swivelled upper grip, stroke limiting switches, forward-reverse switch, elongation gauge, stress-strain recorder, and numerous other valuable features.

Overall height is 63 inches, net weight 162 pounds. Not only does it combine all the musts for a low-range tester, with simplicity of operation and beauty of design, but it is also priced low, within the budget of both large and small shops and laboratories.

——E-64——

CYCLOTRON WILL PRODUCE 200,000,000 VOLTS

▲ Steel for an atom smashing cyclotron magnet designed to produce five times the maximum energy of any now operating will be manufactured by Carnegie-Illinois Steel Corporation. The atom smasher, which will be built at the University of Rochester under joint Navy and university sponsorship, will take 1100 tons of steel forgings and plates, some of the forgings so huge that special freight cars will be necessary to transport them to the university campus.

University officials estimate it will take 18 months to two years to complete the project, which will produce particles of more than 200 million electron volts. The Navy office of research and inventions and the University of Rochester are jointly financing the nuclear research program. The cyclotron will be owned by the Navy, but its construction and operation for basic research will be under the direction of the University of Rochester's physics department.

The 1100 ton cyclotron magnet compares with the 15-ton magnet on the university's present seven-million electron volt atom smasher. Individual forgins weighing as much as 150 tons will be produced at Homestead district works of Carnegie-Illinois, where the biggest forgings were turned out during the war for the Navy.

Assembly of the equipment will take place on the campus at Rochester, New York. ——E-65——

With management, operating and maintenance men, CHIKSAN Swivel Joints get the preference because they provide for easy turning with low torque. This means less strain on pipelines and fittings and easier operation. There's nothing to tighten or adjust... and that means longer service with less maintenance attention and fewer shutdowns. Over 500 different Types, Styles and Sizes for pressures to 3,000 psi. and temperatures to 500° F., providing for full 360° rotation in 1, 2 and 3 planes. Write for latest catalog.

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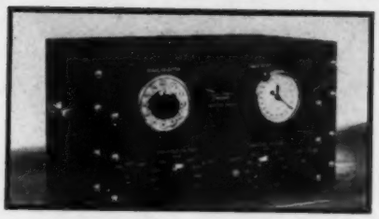
BALL BEARING SWIVEL JOINTS FOR ALL PURPOSES
CHIKSAN COMPANY
BREA, CALIFORNIA
New York 7 Houston 2

AUTOMATIC COUNTER FOR QUANTITATIVE MEASURING

▲ Tracerlab, Inc. announces the "Autoscaler," an instrument for making quantitative measurements of radioactivity. This instrument is a line-operated device which (1) supplies the high potential for a Geiger-Mueller tube, (2) counts the impulses from this tube, and (3) measures the time required for the reception of a given number of impulses. This instrument provides the following special features: Automatic operation with no internal adjustments; automatically stops, and after a predetermined number of counts up to 4096 provides a relay control contact; self-contained unit, including high voltage supply, precision timer and electronic counting circuit; short resolving time; self-calibrating; can be used with all standard Geiger-Mueller tubes; and, fixed statistical error for each setting of the scale selector switch.



The switch shown selects the circuit for a predetermined number of impulses.

Impulses from the counter are fed to a preamplifier, a 2-stage amplifier, and then a multivibrator which triggers the first of a series of twelve "scale by two" counter circuits. The latter can be selected by the switch shown in the upper left of the photograph to provide a predetermined number of impulses from 2 to the second power to 2 to the twelfth power — i.e., 4 to 4096 in integral powers of 2. The statistical error involved in the measurement of an average counting rate by timing a finite number of random impulses is determined by the total number of impulses timed. In the Autoscaler, predetermined counts of 128, 256, 512, 1024, 2048, or 4096 correspond to fixed probable errors of approximately 6, 4, 3, 2, 1.5, and 1 per cent.

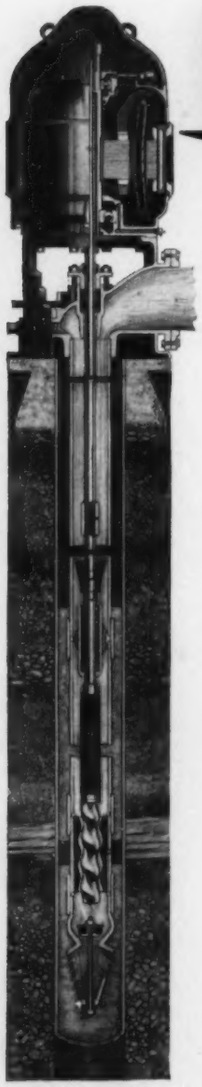
Measurement of the time interval required for the accumulation of the selected number of impulses is accomplished by an output amplifier and cathode follower stage which actuates the clutch of the timer.

——I-66——

RESUME PIG IRON OUTPUT AT TROY BLAST FURNACE

▲ Production of Chateaugay low-phosphorous pig iron has been resumed at the Troy, New York, furnace of Republic Steel Corporation. The furnace has been idle since April 20th when stock piles of the Adirondack ore were exhausted. Termination of the six-month old strike of miners at Republic's ore mines at Lyon Mountain and Port Henry have made ore available once again.

The Troy furnace is rated at an annual capacity of 263,000 net tons. Chateaugay iron is used for specialized foundry work and in the production of acid open hearth steel.



HERE'S HOW
"Squeezing Water Upward"
SQUEEZES UPKEEP DOWN

PEERLESS
HI-LIFT PUMPS
(Reg. U. S. Pat. Off.)

For low-cost, limited water supply demands of multiple industrial uses.

CAPACITIES: 600 to 3300 Gals. per hour FOR WELLS AS SMALL AS 4" INSIDE DIAMETER

Peerless HI-LIFT is the pump that gives magic wings to water lift, with an ingenious pumping element.

Employing simplicity to the best possible advantage, Peerless has replaced high shaft speed, vibration, and high operating cost, found in most conventional type pumps, with a slow, smooth continuous positive pumping action that literally "squeezes" the water upward.

The only moving part in the pumping element consists of a hard, heat-treated, chrome-plated stainless steel rotor, helically contoured and revolving within a similarly shaped cutless rubber stator. Both of these units are highly resistant to abrasive action.

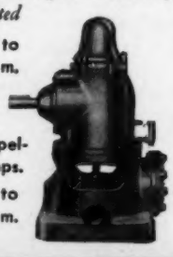
Buy the pump that "squeezes" water upward and squeezes upkeep down. Investigate today the many possibilities offered you with a Peerless Hi-Lift Pump.

SELF-PRIMING NO OIL USED UNDERGROUND

PATENTS: Manufactured under R. Moineau patents, U.S. 1892217, 2028-407 and Re-issue 21374. Canadian Patent 352574. By Exclusive License to Robbins and Myers, Inc. Peerless U.S. Patents 2208937, 2338937 & 2346426. Other Pats. pend.

PEERLESS TURBINE PUMPS
Gearturbo (Right Angle Gear Drive) Illustrated

Capacities up to 30,000 g.p.m.
Oil or Water lubrication.
Hydro-Foil (Propeller Type) Pumps.
Capacities up to 220,000 g.p.m.



PEERLESS PUMP

PEERLESS PUMP DIVISION
Food Machinery Corporation
Canton 6, Ohio Quincy, Illinois Los Angeles 31, Calif.

NEW THERMOCOUPLE FOR MEASURING LOW MELTS

▲ A new portable thermocouple for measuring molten aluminum temperatures and regarded as suitable for measuring lead, babbit, zinc, type metal and similar low melting metal temperatures, has been developed and will be introduced soon by the Brown Instrument Company.

Metal temperatures, according to the Brown company, can be measured below the surface of the bath in a matter of seconds while the readings are unaffected by couple wire conditions and parasitic current generation is wholly absent at the hot junction, situations that occurred formerly.

It is pointed out the new thermocouple has been successfully field tested by two of the largest foundries in the country.

In operation, it was explained, the couple is immersed several inches below the surface of the bath and held there until a steady reading is obtained on the measuring instrument, usually 10 to 12 seconds. The couple is then withdrawn, adhering metal being removed by shaking the handle.

The couple will be supplied, if desired, as part of a complete system comprising a circular chart "ElectroniK potentiometer, an external standardizing accessory for specific requirements, and spare tips and extension leads.

——E-67——

CIRCUIT BREAKER FIRM SPONSORS INVESTIGATION

▲ A German copper contact rectifier which converts alternating current into direct current with 98 per cent efficiency will be investigated by two industry experts who left for Germany on June 19, the Technical Industrial Intelligence Branch, Department of Commerce, has announced. The rectifier was developed by the Siemens-Schuckert firm, Berlin, during the war for use in electroplating, aluminum extraction, chlorine manufacture, and other electrolytic processes.

Otto Jensen, engineer, I-T-E Circuit Breaker Company, began a study of the machinery while he was in Germany for TIIB last year and will now complete the work. He will be accompanied by Elmer Goessel, designer of the same company. Mr. Goessel will draw up plans for construction of similar machinery in the United States.

The investigation is being directed by TIIB, but costs will be borne by the I-T-E Circuit Breaker Company. The investigators' report will be made public through the Office of the Publication Board, Department of Commerce.

According to Mr. Jensen, the German rectifier is 10 per cent more efficient than the mercury arc converter now generally used in the United States.

The rectifier is described in the following reports, recently placed on sale by OPB:

Otto Jensen, "Report on High Voltage Switch Gear" (PB-3477); photostat, $3; microfilm, 50 cents; 39 pages.

Otto Jensen, "German Progress on Mechanical Rectifier or Contact Converter" (PB-3470); photostat, $1; microfilm, 50 cents; 30 pages.

P. R. Tarr, "A New Type of Rectifier for Conversion of Alternating Current into Direct Current Electrical

IS HEAT SLOWING UP YOUR WORKMEN?

TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep Them COOL with TRUFLO FANS

TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
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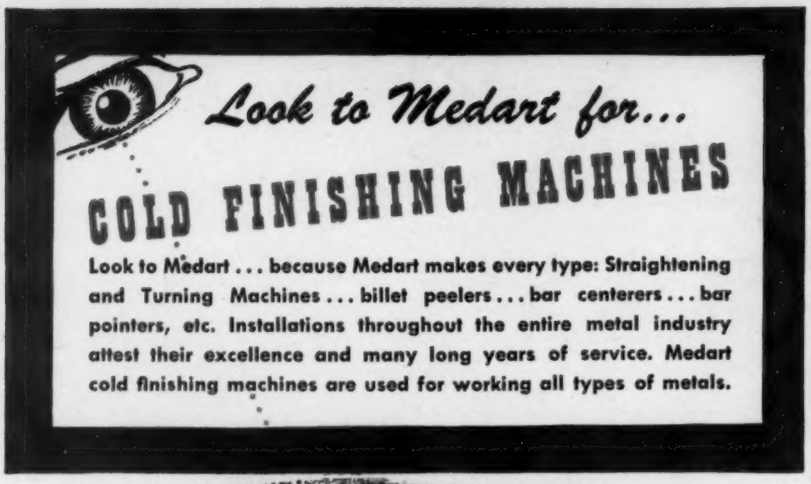
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COLD FINISHING MACHINES
Look to Medart . . . because Medart makes every type: Straightening and Turning Machines . . . billet peelers . . . bar centerers . . . bar pointers, etc. Installations throughout the entire metal industry attest their excellence and many long years of service. Medart cold finishing machines are used for working all types of metals.

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Energy" (PB-6633); photostat, $1; microfilm, 50 cents; 2 pages.

Orders for reports should be addressed to the Office of the Publication Board, Department of Commerce, Washington 25, D. C., and should be accompanied by check or money order, payable to the Treasurer of the United States.

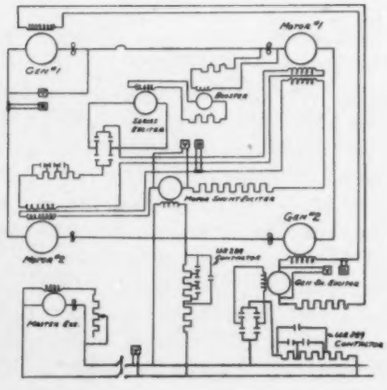
CARBON BRUSHES FOR VARIED PLANT LOADS

▲ There is nothing quite so exasperating to the electrical superintendent of a steel mill as brush trouble. The characteristics of carbon brushes are fixed and cannot be varied at will by the operator to suit the varying load conditions of the motor or generator on which they operate. Sometimes brush trouble is endured for years because earlier tests of the brush grades did not solve the difficulty.

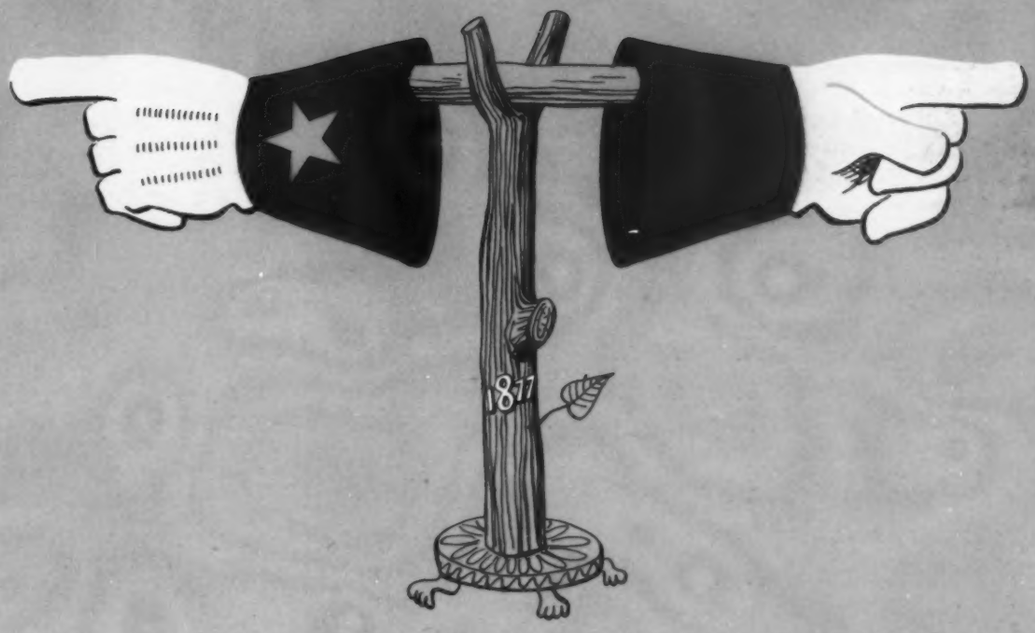
This was the case on a blooming mill motor generator set. This motor generator set consisted of five units, two 1450 kw, 600 volt, 365 rpm generators driven by a 2000 hp, 3 phase, 25 cycle, 6600 volt induction motor. These two generators were connected in series. The two generators in turn drove two 1,500,000 foot pound torque motors whose speed varied from 0-125 rpm. These two motors on the same shaft were directly connected to the blooming mill. The rated load of the generators was 2400 amperes, but there were times that a peak of 12,000 amperes was reached

(*Please turn to page 187*)

The characteristics of carbon brushes are fixed and cannot be varied at will.



We built the first reversing blooming mill . . .

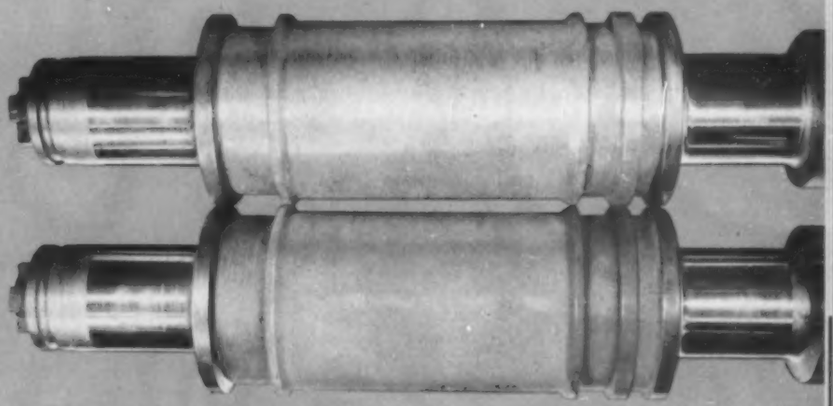


So what? We've been pioneers in developing many types of rolling-mill equipment—so what?

So we've learned, by experience, that metal-rolling is an industrial art—that successful rolling-mill production is dependent upon the skill of the operator *in the proper use* of *the proper rolls.*

Your own rolling experience dictates *the proper use* of rolls; *the proper rolls,* Mackintosh-Hemphill rolls, are engineered by mill-wise Mackintosh-Hemphill to your own specifications based on your own production requirements.

You know your mills—Mackintosh-Hemphill knows roll manufacturing. Let's get together.



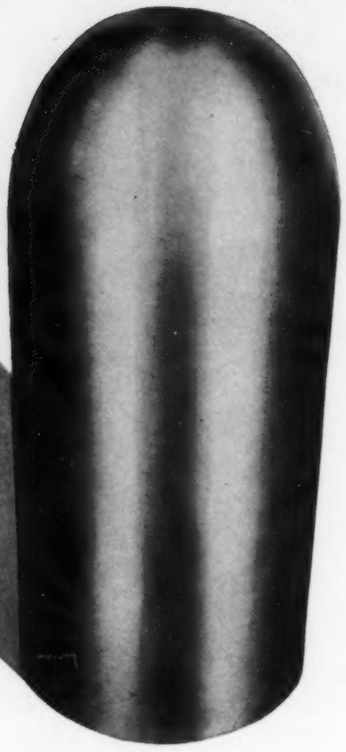
MACKINTOSH-HEMPHILL CO.

PITTSBURGH AND MIDLAND, PENNSYLVANIA

Makers of the rolls with the Red Wabblers

THESE NICKEL CAST IRON EXTRUSION PUNCHES..

Performed 12 times better than those of plain gray cast iron . . .



Machined extrusion punches of Nickel alloyed iron.* Wyman-Gordon use these punches in a 1500-ton press for making extrusions of Type 2512 Steel (5% Nickel) at a forging temperature of 2250° F. These punches measure about 10" long and 4" in diameter.

*Produced by HUNT-SPILLER MFG. CORP. South Boston, Mass.

Metal used for extrusion punches must be *tough* to resist breakage, *strong* to resist deformation, and *resistant* to heat effects involving checking, scoring and roughening.

Proper alloying with Nickel, along with chromium and molybdenum, results in cast irons that meet these rigid requirements.

The table below shows some of the data obtained from extensive tests made by The Worcester, Mass. Division of the Wyman-Gordon Company, a leading producer of aircraft forgings.

Extrusion punches provide just one more illustration of important advantages gained by using Nickel cast irons. In addition to their longer life of useful service Nickel irons can be conveniently cast and easily machined . . . thus effecting obvious economies. Our casting specialists will be glad to consult with you and suggest where Nickel Alloy Irons may be useful to you.

The low strength of unalloyed gray iron was responsible for this typical failure by fracture at root of stud recess after a short service life.

COMPOSITION AND SERVICE LIVES OF GRAY CAST IRON EXTRUSION PUNCHES

No.	TYPE	CHEMICAL COMPOSITION										Range of Lives	Average Life	B.H.N.	Type of Failure
		T.C.	G.C.	Si	Mn	P	S	Ni	Cr	Mo.	Cu				
1	Unalloyed	3.16	2.48	1.85	1.08	.22	.10	.00	.12	.02	.05	3-143	38	207-217	Broke
2	Mo	3.10	2.50	1.88	1.12	.18	.06	.00	.15	.28	trace	13-399	122	223-228	Broke
3	Cu-Cr-Mo (Intermediate Phos.)	3.05	2.05	1.75	1.20	.24	.07	.00	.65	.45	1.50	2 56	28	217-241	Broke
4	Cu-Cr-Mo (Intermediate Phos.)	2.92	2.08	1.82	.96	.20	.09	.00	.46	.44	1.50	8-352	186	202-228	Broke
5	Ni-Cr-Mo (Low Phos.)	.82	2.02	2.26	.86	.09	.08	1.85	.28	.71	trace	45-774*	311	228-240	Bent, Roughened or Broke
6	Ni-Cr-Mo (Low Phos.)	2.60	1.91	2.13	.64	.13	.07	2.28	.21	.78	trace	42-1370†	470	228-240	Bent, Roughened, Broke or Stud Pulled Out

*11 castings failed after making less than 240 forgings. 5 castings made more than 410 forgings. All others between 240 and 430 forgings each. †7 castings failed after making less than 240 forgings. 3 castings made more than 1000 forgings. All others, 240 to 1000 forgings.

EMBLEM OF SERVICE INCO Nickel TRADE MARK

Over the years, International Nickel has accumulated a fund of useful information on the selection, fabrication, treatment and performance of alloys containing Nickel. This information and data are yours for the asking. Write for "List A" of available publications.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

PARTIAL INTERIOR VIEW IN A MODERN HARBISON-WALKER PLANT

H-W *Mortar* MATERIALS

Equal in importance to the proper selection of refractory linings is the choice of the mortar material used as a bond. Harbison-Walker bonding mortars will insure maximum life of furnace linings.

HEAT SETTING BONDING MORTARS

FINE GROUND FIRE CLAYS
SUPER FIRE CLAY MIXTURE
HIGH-ALUMINA MORTAR MIX
FURNACE MAGNESITE
H-W SPECIAL MORTAR MIXTURE
HIGH-ALUMINA CLAY — STAR SILICA CLAY
H-W SPECIAL FURNACE CHROME
H-W WEATHERED BOND "B" CLAY
STARBOND (SUPER-DUTY) SILICA CLAY MORTAR

AIR SETTING BONDING MORTARS

HARWACO BOND (Diaspore Base)
FIRE BOND (Silica Base)
THERMOLITH (Chrome Ore Base)
PERIKLASE BONDING MORTAR (Magnesia Base)
KORUNDAL BONDING MORTAR (High-Alumina Base)
FORSTERITE BONDING MORTAR (Magnesium Silicate Base)
CORALITE BONDING MORTAR (High-Alumina Base)

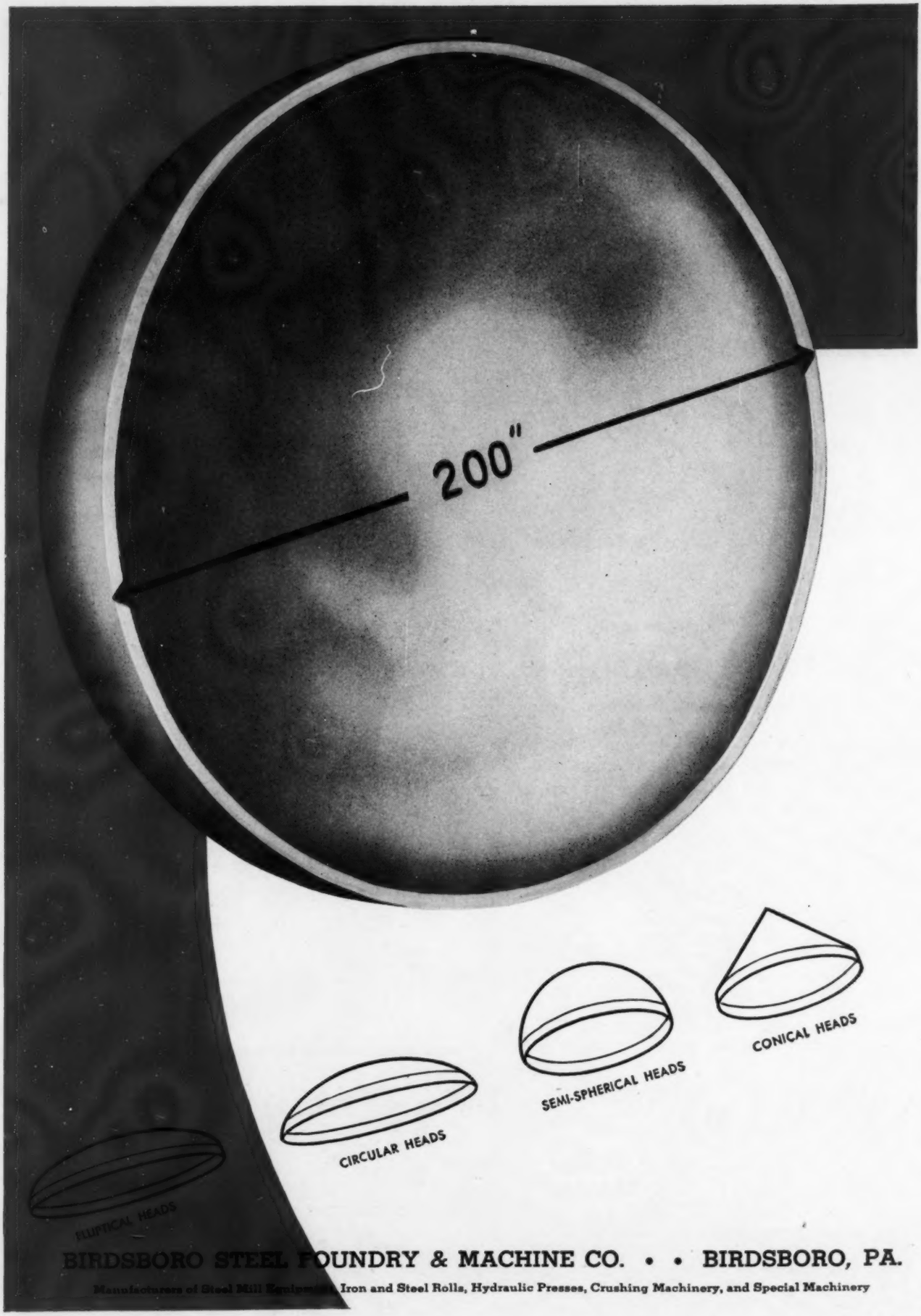
H-W *Ramming* MATERIALS

Based upon a thorough knowledge of the requirements, Harbison-Walker has developed ramming materials which are established as standard in industrial plants throughout the world.

H-W RAMMING MATERIALS

PLASTIC THERMOLITH BATCH (Chrome Ore Base)
DRY THERMOLITH BATCH (Chrome Ore Base)
PERIKLASE BATCH (Magnesia Base) — H-W GANISTER (Silica Base)
H-W MAGNAMIX (Washington Magnesite)
H-W KORUNDAL RAMMING MIXTURE (High-Alumina Base)

HARBISON-WALKER REFRACTORIES COMPANY
AND SUBSIDIARIES
WORLD'S LARGEST PRODUCER OF REFRACTORIES
GENERAL OFFICES, PITTSBURGH 12, PENNA.



BIRDSBORO STEEL FOUNDRY & MACHINE CO. • • BIRDSBORO, PA.

Manufacturers of Steel Mill Equipment, Iron and Steel Rolls, Hydraulic Presses, Crushing Machinery, and Special Machinery

GIANT SIZE DISHED HEADS

Accurately Spun at Low Cost

ON BIRDSBORO FLANGE SPINNING MACHINES

When you have an "out-size" dishing job, look to Birdsboro Flange Spinning Machines to give you close tolerances and low cost as well as speedy operation. The machine shown is flexible in control and capacity, has a clearance of 17' between columns and forms flanged and dished heads from plates ¾" to 4" thick.

Designing and building such special purpose machinery is an everyday function here at Birdsboro. Our engineering staff is ready at all times to cooperate in applying their specialized knowledge to give you a practical solution to your heavy equipment problems.

BIRDSBORO

STEEL MILL EQUIPMENT

Interior of hearth lining looking toward iron notch. Blocks may be of any size desired up to 24x30x180 in.

● The trend is strong toward use of carbon for blast furnace linings. Why? Just consider the valuable advantages of this basically different kind of lining material—

1 Lasts indefinitely!

A properly-installed carbon block lining in a blast furnace should last indefinitely. This results from the remarkable physical properties of carbon: no melting point, low thermal expansion, highly resistant to thermal shock, not wet by molten metals, immune to metal and slag attack, mechanical strength maintained at high temperatures.

2 No Salamander!

Years of experience with carbon linings bears this out. Consider what a saving this feature, alone, can mean to you.

3 Fast, easy to install!

One carbon block can take the place of from 50 to 1000 nine-inch firebrick, depending upon the size of the block. Overall installation time is thus greatly reduced.

4 Economical in long run!

Operating experience is proving that carbon linings are definitely more economical in the long run . . . as is evident from the features outlined at left.

WHATEVER YOUR PROBLEM — CONSIDER CARBON OR GRAPHITE

Get more details:

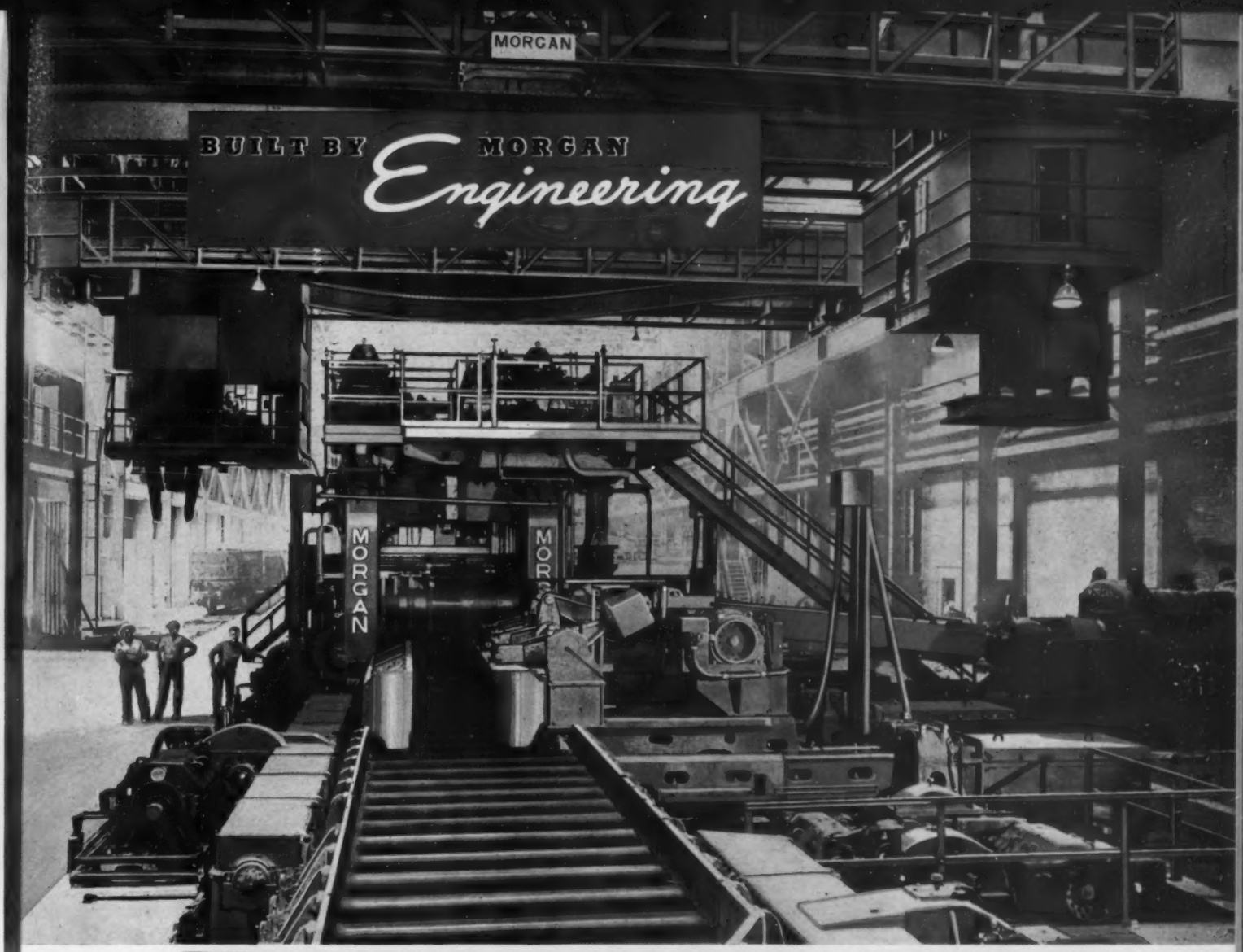
Engineers at National Carbon Company, Inc., will be glad to supply you with full available information on all phases of installing a carbon lining. Write today **to Dept. IS.**

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation
"The word "National" is a registered trade-mark of National Carbon Company, Inc.

UCC

30 East 42nd Street, New York 17, N. Y.
Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco



MORGAN "36" TWO-HIGH BLOOMING MILL

GROUPED OVER THE MILL IS A MORGAN 7½-TON SOAKING PIT CRANE AND A MORGAN 200-TON 81'-3" SPAN UNIVERSAL TYPE INGOT STRIPPER

With this Mill was furnished Auxiliary Equipment as follows — Front and Rear Tables with Manipulator — Approach Table — Ingot Buggy — Runout Tables — Slab Shear with Gauge — Crop Hoist — Pushers — Conveyor — Skid Bed and Furnace Tables.

Above is shown a Morgan 36" two-high blooming mill complete with double manipulator, front and rear tables. Three mills of this type were recently furnished prominent mid-west steel producers. Housings are one-piece steel castings of the closed top type. Top roll balance is of the counterweight type.

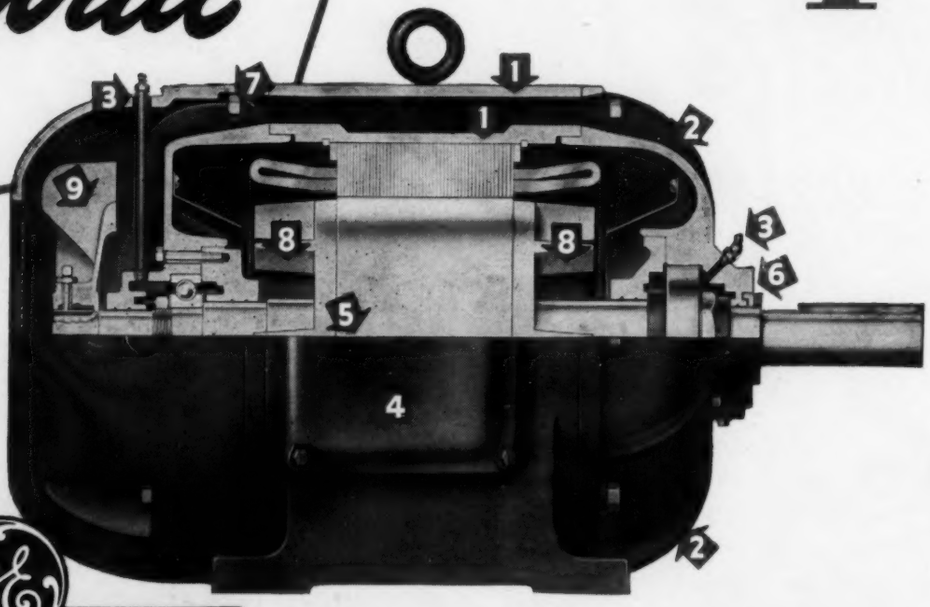
Manipulator is of the overhead type, compact and accessible. Tables are of heavy design, equipped with anti-friction bearings. Screw-down drive is arranged to provide crane hook access when changing guides. Provision is made for automatic lubrication and exclusion of scale and dirt.

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO. 1420 Oliver Building, Pittsburgh

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

A Double Wall Keeps



TRI/CLAD

TOTALLY ENCLOSED STANDARD and EXPLOSION-PROOF MOTORS

These 9 points of new strength and serviceability put this TRI/CLAD totally enclosed motor way ahead.

1. A cast-iron, double-wall frame that completely encloses windings and punchings
2. Ribbed, cast-iron end shields, machined to provide a tight seal, yet easily removed
3. Well-proved, pressure-relief greasing system which can be packed with a long-life lubricant where advisable
4. Cast-iron conduit box diagonally split for wiring convenience (independently explosion-proof on explosion-proof motors)
5. Leads are sealed in a nonshrinking compound at the point where they emerge from the frame
6. Rotating labyrinth seal prevents infiltration of grit or liquids
7. Large, free-flowing, easy-to-clean air passages protect parts from accumulation of dust and foreign material
8. Modern "ageless" insulation treatment includes Formex* magnet wire
9. Powerful external fan is removable, simplifying maintenance (nonsparking type for explosion-proof motors)

AND IN ADDITION—compactness and short length promote ease of handling and installation

*Trade-mark reg. U.S. Pat. Off.

FOR THE COMPLETE STORY

Apparatus Department
General Electric Company
Schenectady 5, N. Y.

Please send me GEA-4400, which describes the new Tri-Clad totally enclosed motor.

Please send me GEA-4131, "Motors and Control for Hazardous Locations."

Name.....

Company.....

Address.....

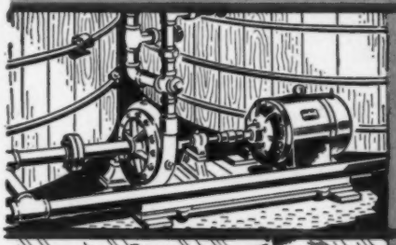
750-257-8080

GENERAL ELECTRIC

Trouble Out

NEW TRI/CLAD TOTALLY ENCLOSED MOTOR IS MORE FULLY PROTECTED FROM DUST, DIRT, WEATHER, OR WHAT HAVE YOU...

Now, General Electric has applied Tri-Clad construction to its line of totally enclosed induction motors (1 to 1000 hp) and to most of its explosion-proof motors as well. *Extra protection* has been raised another notch.

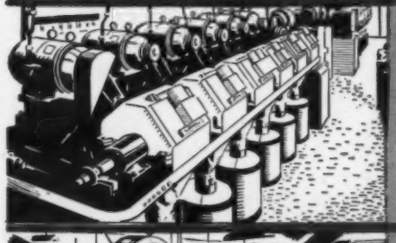


FOR EXTRA-SEVERE JOBS

Applications amid dust, metal filings, coolants, or corrosive agents—where totally enclosed motors have always been required—will now have the benefit of a stronger armor, plus convenience features that simplify installation and servicing.

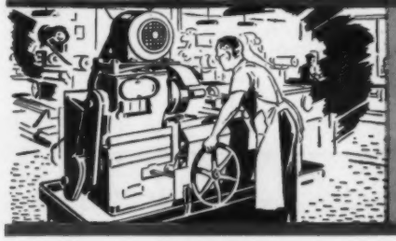
FOR EXTRA-WET LOCATIONS

Indoors or out, these Tri-Clad totally enclosed motors will take hosings or heavy rains without danger of shutdown. The cast-iron frame is strongly resistant to rust and corrosion.



FOR HAZARDOUS ATMOSPHERES

"Companion motors" to the standard Tri-Clad totally enclosed, the new explosion-proof and dust-explosion-proof types are tested and listed by Underwriters' Laboratories for Class I, Groups C and D, and Class II, Groups E, F, and G.



FOR EXTRA-LONG LIFE

Many motor users are making the totally enclosed motor their standard for *all* jobs—based on evidence of long-term savings. This new member of the Tri-Clad line makes this decision more logical than ever.

F. E. I. EQUIPMENT

Direct-Fired Cover Furnaces for annealing, spheroidizing, Normalizing and Bright annealing of wire, rods, coiled strip, flat sheets and tin plate.

For Heavy Coil Loads: Patented Convection Base, gives 2 to 4 times longer service.

For Wire, Bar and Tube Mills: Galvanizing, Patenting and Normalizing Furnaces.

For Pipe, Sheet, and Job Plants: Hot Dip Galvanizing Furnaces.

Car Type Furnaces, Rod Heating, Lead Quenching, Ladle Heating and Salt Bath Descaling Furnaces.

In steel and non-ferrous production, wherever heat treating is done on a large scale, skilled engineering service is essential to best results.

Among the many types of furnace equipment offering possibilities for any given application, the furnace engineer must, without favor or prejudice, and with thorough insight into comparative merits of different types, make recommendations with a single eye to obtaining for his client the utmost in performance.

Because of strict adherence to this principle and 30 years of specialization in production heating problems, F.E.I. engineers have been signally successful in serving many of America's outstanding producers of rod, wire, sheets, strip and shapes. These F.E.I. services are yours for the asking, without cost or obligation on your part. *Our recommendations are not limited to equipment of our own manufacture.*

Performance Records on the latest and most advanced types of F.E.I. equipment, installed in various plants of national prominence, are furnished on request. Some of these records show qualitative and quantitative results far beyond anything heretofore considered possible. Study the facts—they are most illuminating!

FURNACE ENGINEERS, Inc.

Foreign Representatives { FOR CANADA: Salem Engineering (Canada) Ltd. Toronto, Ont. / FOR EUROPE, ASIA, AFRICA: Salem Engineering Co. Ltd., Milford, Nr. Derby, England.

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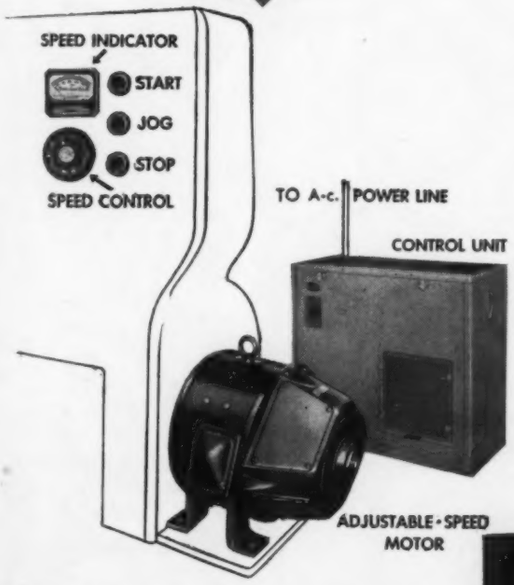
STEPLESS Speed Changes

. . from A-c. circuits!

RELIANCE V★S DRIVE

V★S, the *All-electric, Adjustable-speed Drive operating from A-c. Circuits,* brings to any production or processing operation an unlimited selection of *stepless* speed changes. Acceleration and deceleration are unbelievably smooth. And every V★S function can be performed automatically or manually, with all-electric control from nearby or remote stations!

Whatever flexibility of operation you need to increase quantity and quality of output can be provided the V★S way—simply, safely and economically. V★S control means instantaneous starts and stops—slow speeds for inching, threading or close inspection of work in process—maintenance of proper tension——reversal at any point desired. For more money-saving facts about the V★S Drive write for Bulletin 311.



Conveniently-packaged, space-saving V★S Drives available in Rotating or Electronic Systems or a combination of both.

RELIANCE ELECTRIC & ENGINEERING CO.

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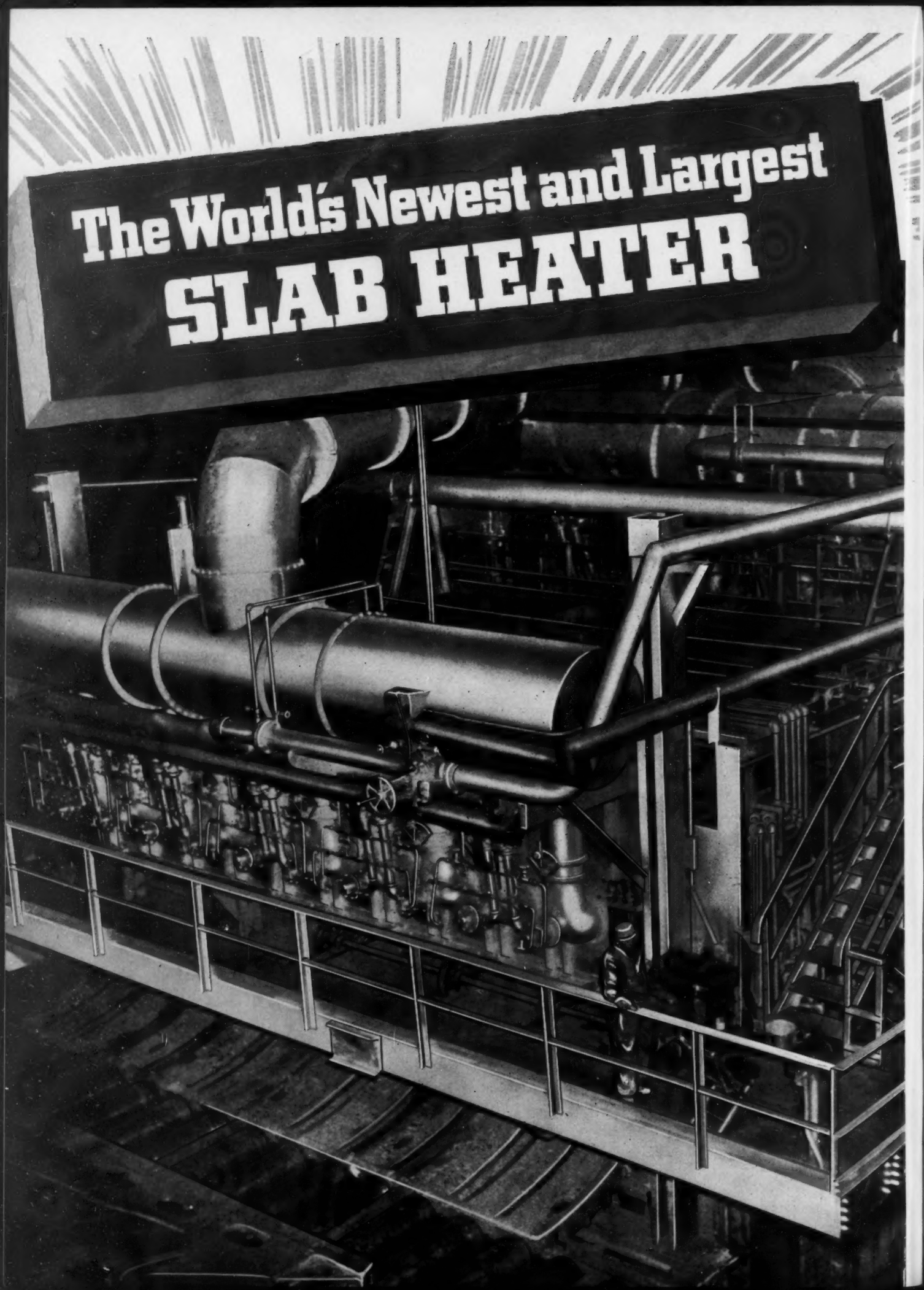
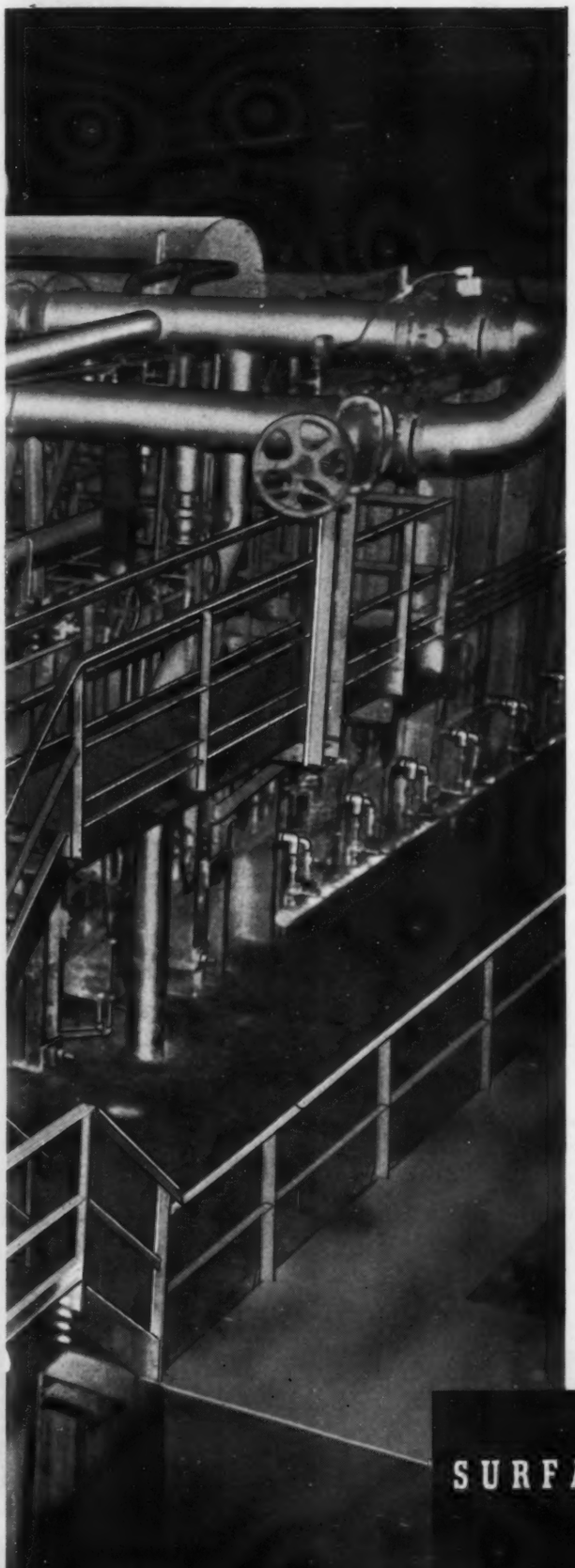
RELIANCE A-C D-C MOTORS

"Motor-Drive is More Than Power"


The World's Newest and Largest
SLAB HEATER

Giant Slabs of Steel, Weighing Over 3 Tons Each are, Heated at a Production Rate up to 280,000 Pounds per Hour.



IN the initial processing of coiled strip steel, used for tin plating, huge steel slabs, 150 in. x 42 in. x 5½ in., and weighing approximately 6200 pounds each, emerge from this Surface Combustion Slab Heating Furnace, the newest and largest in the world, installed in the plant of Weirton Steel Company, Weirton, W. Va.

This furnace is 94' 9" in length and the width is 28' 0". It is of the recuperative type and has a "Tripled-Fired" burner arrangement of Surface Combustion design.

Here is another outstanding example of 'Surface' engineering, manufacturing and installation of modern heating and heat treating equipment in the steel producing industry. Other equipment includes One-Way Fired Soaking Pits—Billet Reheating Furnaces—Continuous Heat Treating Furnaces for Plate—Pit Type Convection Furnace for Annealing Rod Wire and Strip in coils—Continuous Strip Annealers and Normalizers—High Alloy Rod and Bar, Atmosphere Annealing Furnaces of Car-Bottom, Lift-Cover Type—Bright Annealing and Normalizing Furnaces for Tubing—Stress Relief Furnaces—Wire Patenting Furnaces—Annealing Covers, and the foremost equipment in Prepared Gas Atmosphere Generators for practically every heat treating operation.

We will welcome the opportunity of working with you on your heating and heat treating problems.

'Surface'

SURFACE COMBUSTION CORPORATION

TOLEDO 1, OHIO

NOW WHAT?

In Boat Building or Plant Wiring, Thoughtlessness Comes High

Enthusiastic skippers have been known to build boats in their cellars — and tear down cellar walls later on! Some planners of electrical systems for iron and steel plants have also lacked essential foresight, and have found that this lack proved even more costly.

Only Adequate Wiring can equip an industrial building for future growth, can insure systems that supply present and future power and lighting demands at the lowest cost per kilowatt consumed. Let an Okonite engineer work with you in planning full electrical efficiency with an eye on tomorrow as well as today. Let him suggest Okonite-designed wires and cables that have proved their fitness for the recommended service . . . that are long-lived not only because they are built with ample strength mechanically but also because they have a combination of electrical properties that reflects the background of Okonite's years of pioneering in the development of insulations. The Okonite Company, Passaic, New Jersey.

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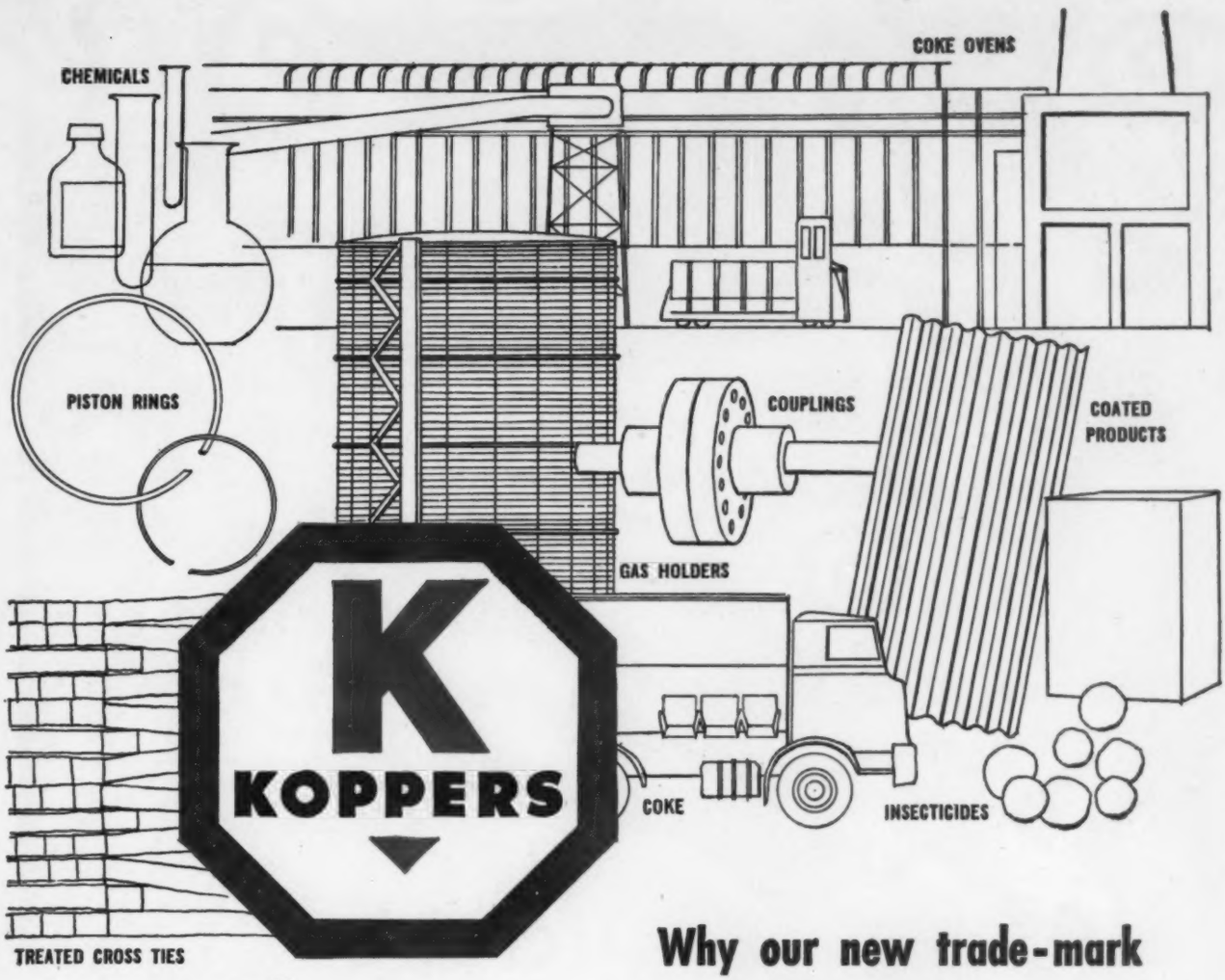
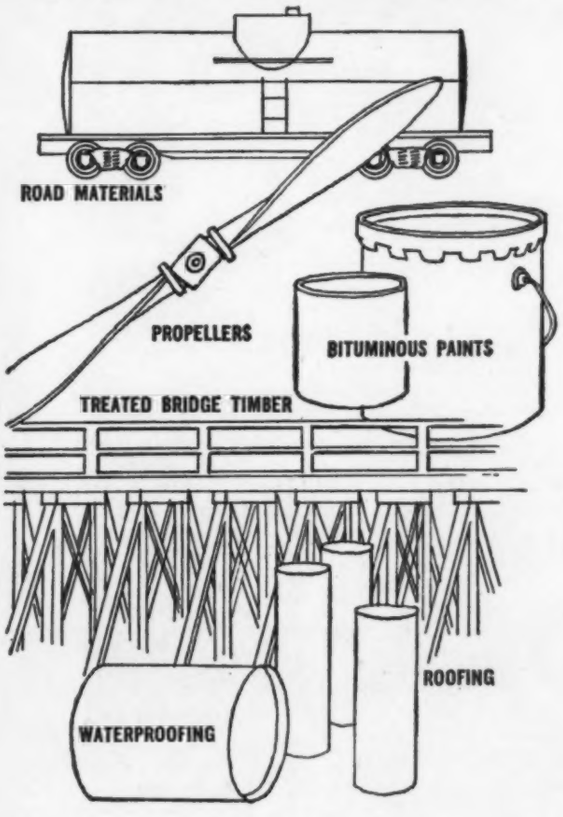
OKONITE SINCE 1878

insulated wires and cables for adequate wiring at its best





Why our new trade-mark is important to you

Every day, you place your health, your safety, your children, even your life at the mercy of manufacturers whose products you trust.

Often you do it because of some small mark which doesn't actually say anything in words, but which says volumes in the meanings you read into it.

That's what trade-marks mean to the American people. In effect, the trade-mark says, "Here is a manufacturer who is so sure of this product that he puts his name on it."

That's why our new Koppers trade-mark is important to you.

There are dozens of Koppers products; there will be dozens more as opportunities expand in the rapidly growing chemical field.

Often you will not be able to see the Koppers label on those products—you can't see it, for example, on road paving material or on a bottle of medicine—but the roadbuilder sees it and the medicine maker sees it, and their confidence in it is your safeguard.

Koppers also is well known as a dependable source for many other products and services which we furnish directly, such as the design and construction of coke ovens, roofing material, piston rings, couplings, propellers for your private plane, coke for your furnace, moth balls for your clothes, paints, pressure-treated wood and scores of others.—Koppers Company, Inc., Koppers Building, Pittsburgh 19, Pa.

KOPPERS—THE INDUSTRY THAT SERVES ALL INDUSTRY

WHY BUY
SO MANY
CARBON
BRUSH ITEMS?
STEEL COMPANY CUTS BRUSH ITEMS FROM 3370 TO 495
Makes big saving, weeding out unnecessary brush items and inventories

CHECK the number of motor and generator brush sizes and types your company orders and stocks. The number will surprise you. Even more startling, if you investigate further, is that a great part of this inventory is really unnecessary!

National Carbon Company, Inc., has launched a program of simplification and standardization to the greatest possible degree of carbon, graphite, and metal-graphite brush specifications. Eventually, the result of such effort will be the stocking of brushes of standardized types and grades.

It's a certainty that you can save money for your company by reducing the variations in brush specifications and by streamlining your brush orders and inventories. National Carbon Co., Inc., is ready to assist you in taking advantage of this program. Simply get in touch with our nearest Division Office today. Dept. IS.

HOW BRUSH SIMPLIFICATION PAYS:

1. Price advantage through quantity discounts.
2. Reduction of small orders—saving time in bookkeeping, billing, and accounting.
3. Less money and space tied up in brush stocks.
4. Less time needed to handle stock.

The word "National" is a registered trade-mark of

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Unit of Union Carbide and Carbon Corporation

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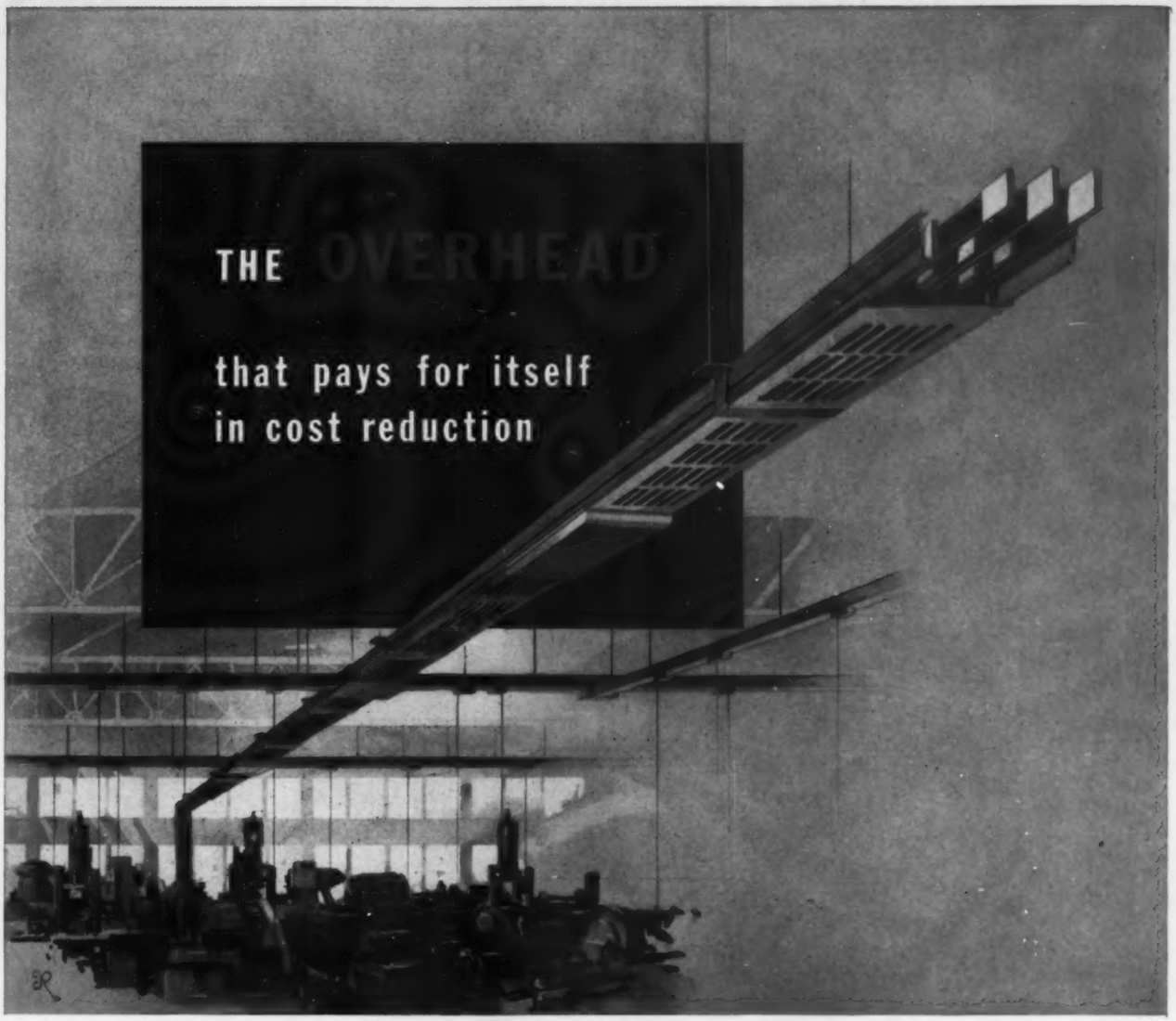


TRUMBULL (T) ELECTRIC

FEEDER DISTRIBUTION SYSTEMS

In exactly the same way that accidents, road blocks and costly maintenance plague the highway department when a road system is inadequate—so do plant managers pay for inadequate electrical power distribution.

Machines cannot efficiently operate at less than their rated voltage—overloaded lines in your plant mean costly patching of your distribution system—MONEY OUT OF YOUR POCKET.

Your inadequate distribution system is no doubt making you pay now for a full-powered, low-cost Trumbull Feeder Distribution System.

Trumbull Buss-Wa Systems (main feeders) Flex-A-Power (branch feeders) and Control Centers (motor control distribution) are available to you NOW.

Write directly to Trumbull Electric Mfg. Co., Plainville, Conn., for further information.

Available now FROM FACTORY STOCK

THE TRUMBULL ELECTRIC MANUFACTURING CO. • PLAINVILLE, CONN.

Other Factories at NORWOOD, OHIO • LOS ANGELES • SAN FRANCISCO • SEATTLE

Here's the new *EASY* index method of selecting *MORGANITE* MOTOR BRUSHES!

EXACT, CONCISE INFORMATION FOR SPECIFYING BRUSHES FOR TYPES MC, MD, CD, SWS, SK AND T MOTORS

Copies may also be obtained at our BOOTH No. 202 IRON & STEEL EXPOSITION CLEVELAND, OHIO October 1st to 4th inclusive

TYPE MC
TYPE SWS
TYPE CD
TYPE MD
TYPE T
TYPE SK

MORGANITE engineers expressly prepared this comprehensive booklet to save the time of purchasing agents, steel mill engineers and production maintenance men when selecting motor brushes. Complete information is contained therein covering all types of motors commonly used, and the brushes best suited for efficient, uninterrupted operation.

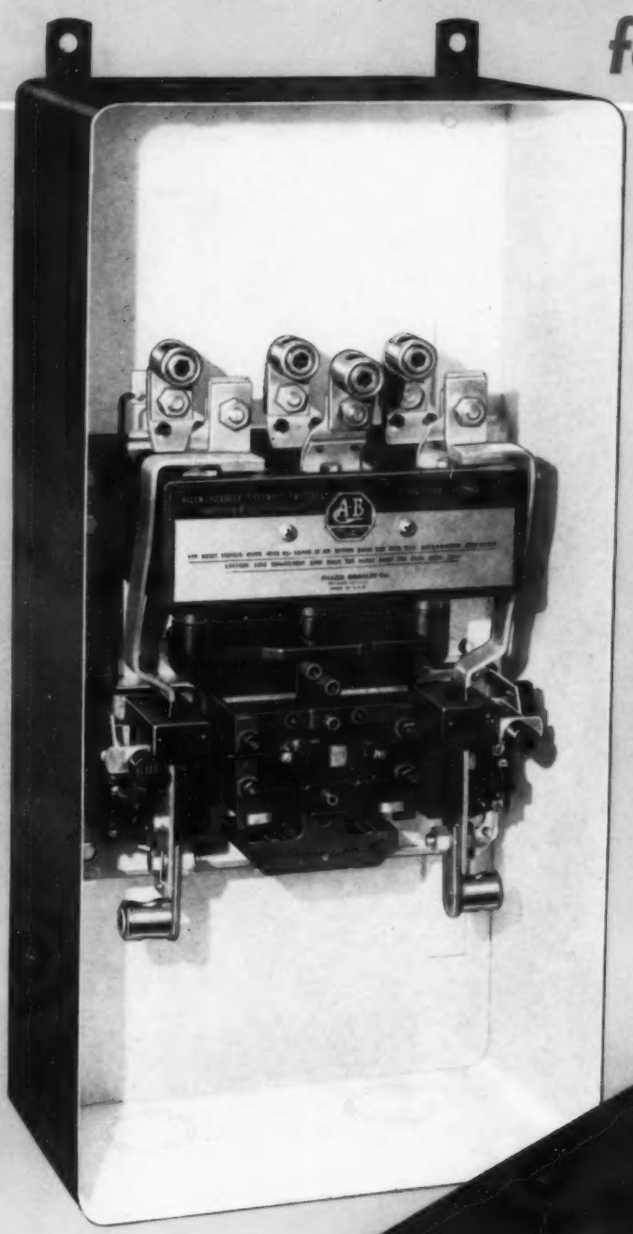
While the text is not a detailed technical treatise, it is an invaluable reference. It has been edited with the purpose of reducing steel mill motor maintenance costs through proper brush specification.

This bulletin is distributed by our sales engineers, who will gladly call upon request. Address Morganite Incorporated, Long Island City 1, New York.

Morganite CARBON BRUSHES

The Ideal Starter

for Steel Mill Auxiliaries



RUGGED . . . TROUBLE-FREE

Bulletin 709
300 Ampere, Size 5
A-C Across-the-Line

Solenoid Starter

Here is a husky, trouble-free motor starter built to stand up under the toughest steel mill service. Its double break, silver alloy contacts never need maintenance during their lifetime. The rugged solenoid operated starter is mounted on a rigid *steel* base plate. A large reduction on weight obtained by using steel instead of slate permits easy removal of the starter from the enclosure during installation. The solenoid design makes possible large electrical clearances in a switch mechanism of small over-all dimensions. Yet large space is provided for wiring. The steel enclosing cabinet is bonderized and has an attractive baked enamel finish that resists corrosion.

MAXIMUM RATINGS:
100 hp, 220 volts
200 hp, 440-550 volts

SEE THE ALLEN-BRADLEY DISPLAY AT THE IRON AND STEEL EXPOSITION CLEVELAND, OHIO, OCTOBER 1 TO 4 BOOTHS 308-9

A-B Quality

ALLEN-BRADLEY

SOLENOID MOTOR CONTROL

QUALITY

Only 1 Moving Part

- ✓ DOUBLE BREAK SILVER ALLOY CONTACTS
- ✓ NO CONTACT MAINTENANCE
- ✓ SIMPLE CONSTRUCTION
- ✓ COMPACT
- ✓ EASY TO INSTALL

You get these advantages in the Allen-Bradley *Solenoid Starter*

You can get the recognized benefits of solenoid construction—not only in small starters, but in ratings up to 300 amperes. Because of their inherent simplicity and ruggedness, Allen-Bradley solenoid starters have proved their value in the toughest kind of service. They have no pivots, pins, hinges, or bearings to gum up or corrode and cause trouble. The double break, silver alloy contacts never need maintenance. Allen-Bradley solenoid starters are good for millions of trouble-free operations. Write for complete information today.

ALLEN-BRADLEY CO.
1316 S. Second Street
Milwaukee 4, Wisconsin

ALLEN-BRADLEY
SOLENOID MOTOR CONTROL

QUALITY

Personnel News . . . .

Arthur C. Wilby has been elected vice president of United States Steel Corporation of Delaware. Mr. Wilby, who has been associated with United States Steel since January 9, 1909, will maintain his headquarters in Chicago, Illinois.

A native of Waterloo, Iowa, where he was graduated from high school and business college, Mr. Wilby came to United States Steel as a salesman for the subsidiary, Universal Atlas Cement Company. Prior to joining the corporation, he had been a clerk with the Illinois Central Railroad in Waterloo and later assistant superintendent of the Waterloo Cement Machinery Corporation. With Universal Atlas, he progressed through various positions until he became assistant to the president, January 1, 1917.

Mr. Wilby was appointed Chicago District Manager of Public Relations, Carnegie-Illinois Steel Corporation, January 1, 1937. At the same time and until 1939, he also was in charge of the liquidation of surplus properties belonging to United States Steel subsidiaries. Since July 5, 1938, he has been in charge of public relations for United States Steel subsidiaries in the Chicago District.

Edward C. Logelin, Jr. was appointed as director of public relations, United States Steel Corporation subsidiaries, Chicago District. He succeeds **Arthur C. Wilby,** who was elected vice president, United States Steel Corporation of Delaware, August 14.

Mr. Logelin has been principal assistant to Mr. MacDonald since 1943. Born and educated in Chicago, he began his business career with the WFL Drum Company as a stenographer in 1928 immediately after graduating from high school. He later served as assistant editor of the company's musical publications. He has been associated with United States Steel since March 1930, when he began in the advertising department of Universal Atlas Cement Company.

He became assistant to Mr. Wilby, who was the manager of public relations, Chicago District, Carnegie-Illinois Steel Corporation, in 1937 and in 1941 was named assistant director of public relations, United States Steel Corporation subsidiaries in Chicago.

As assistant to Mr. MacDonald, Mr. Logelin has been active in the administration of United States Steel's public relations activities. Under Mr. MacDonald's direction, he has planned and coordinated the Corporation's newspaper public relations advertising and has aided in the production of educational motion pictures including "Behind the Annual Report," U. S. Steel's pioneering film, presenting statistical data in dramatic form. He also assisted in organizing the Corporation's radio staff.

James Riddell was appointed chief electrical engineer of Aetna-Standard Engineering Company. He has been in Aetna-Standard's Engineering Department for the past eight years in various capacities, and more recently has been assistant chief electrical engineer.

Before coming to Aetna-Standard, he was in the engineering department of the Great Lakes Steel Corporation in connection with construction and maintenance engineering. He went to Great Lakes Steel at the start of construction of the original plant, and was there during this building program and the subsequent addition of the large hot strip mill and cold strip mills. He left Great Lakes for a short time to go to the Corrigan-McKinney plant of Republic Steel Corporation during the building of their large hot and cold strip mills, returning later to Great Lakes.

Before going to Detroit, he was in the engineering department of the Warren plant of Republic Steel while their hot and cold strip mills were being rebuilt and expanded. Before going to the Warren plant, he had been in the engineering department of Republic Steel Corporation in Youngstown, Ohio.

Astor L. Thurman was appointed assistant to the

EDWARD C. LOGELIN, JR.

JAMES RIDDELL

ASTOR L. THURMAN

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Peace — War — Peace — it is always the same story. We could get out more of this or that if we could get more steel.

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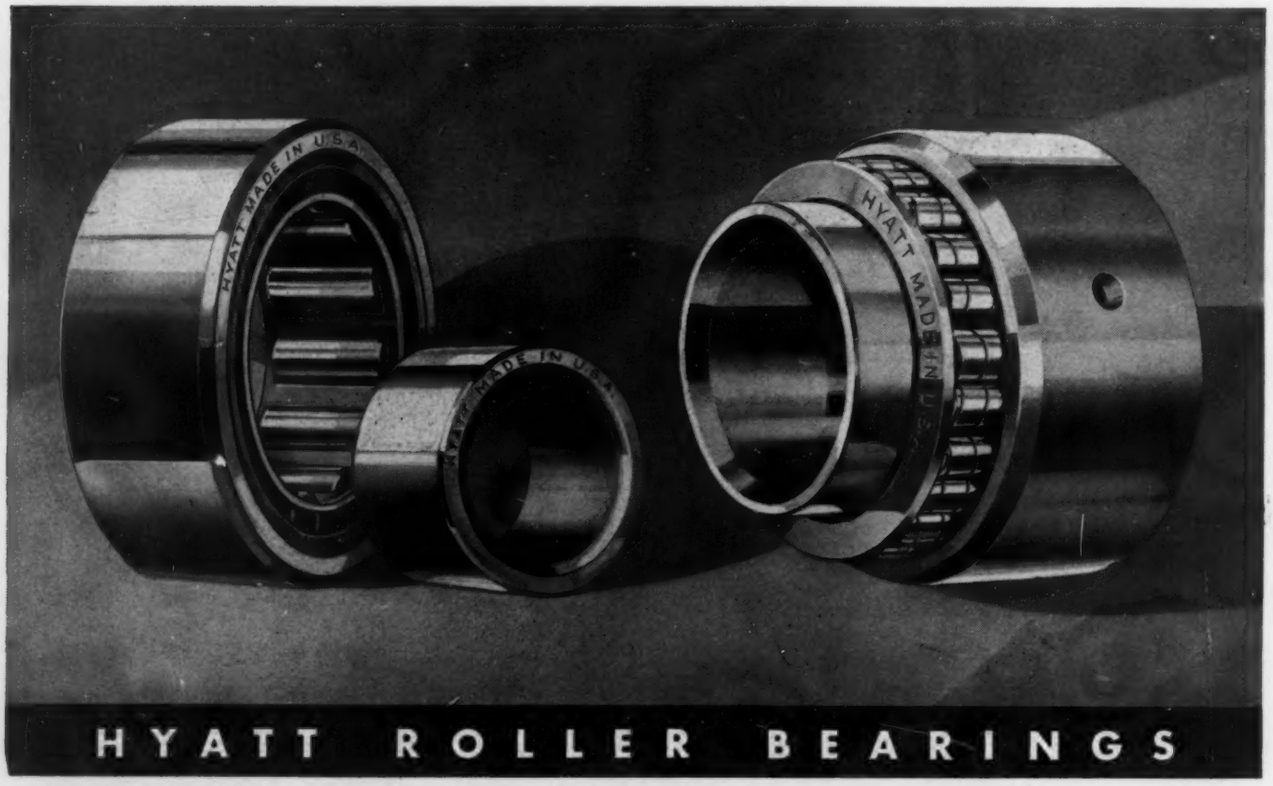
Always specify Hyatt Roller Bearings for new equipment or change-overs and see us in spaces 286 and 287 at the Iron and Steel Exposition in the Cleveland Public Auditorium on October 1-2-3-4.

Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.



vice president of Aetna-Standard Engineering Company. Mr. Thurman went with Aetna-Standard as chief electrical engineer December 1, 1945 after 8½ years with the General Electric Company at Schenectady, New York. He has worked with electrical and mechanical equipment for the steel industry since starting to work on the General Electric test course, and from 1941 until he went to Aetna-Standard, was steel mill application engineer in the steel mill division of the General Electric Company.

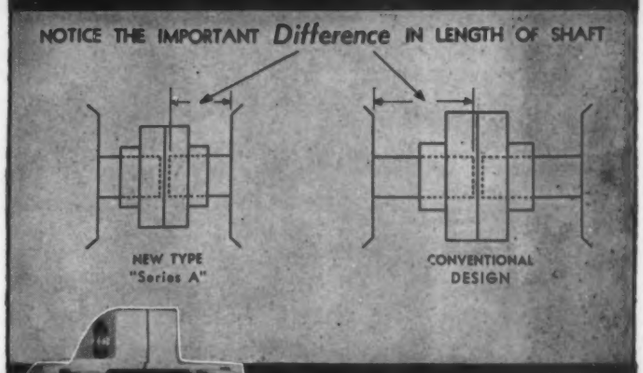
Mr. Thurman has a broad background of learning and experience in the electrical and mechanical engineering fields. A graduate of Oklahoma A. & M., he holds three degrees, a bachelor of science in mechanical engineering, and a bachelor of science and master of science in electrical engineering. At the General Electric Company, Mr. Thurman completed the general course in engineering and business as part of the General Electric test course, the three years of the advanced course in engineering, and the sales course.

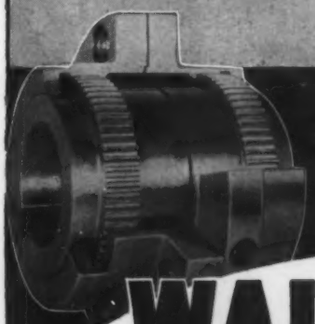
K. Feller was appointed general manager of the newly-formed Feller Engineering Division of the Lake Erie Engineering Corporation, with headquarters in the

K. FELLER

Empire Building, Pittsburgh, Pennsylvania. Prior to organizing the Feller Engineering Company in 1945, Mr. Feller was president and general manager of Schloemann Engineering Corporation of Delaware, after having served as manager of the American branch and in other executive positions of the Schloemann Company abroad. Mr. Feller is known and recognized in trade circles as an outstanding engineer and specialist in the field of extrusion, having had long and broad experience in the practical phases and development of this work.

No Wonder This New Coupling Design Has Made A Hit With Coupling Buyers





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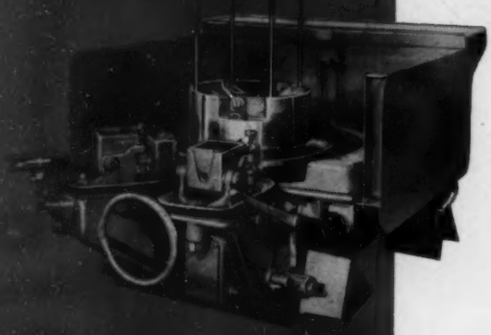

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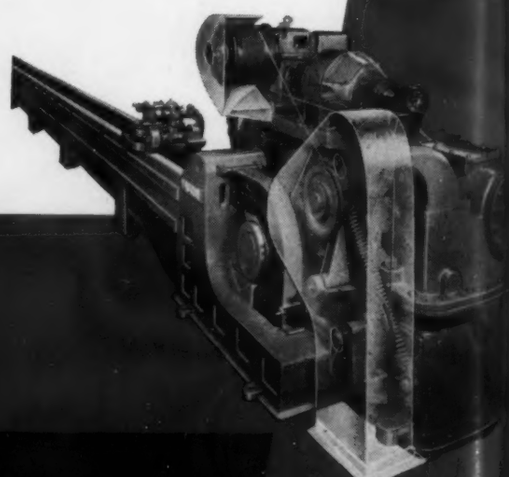

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F. W. LORIG

Frank W. Lorig has been appointed division engineer of the Cyclone Fence Division of the American Steel and Wire Company. At the same time, **Charles F. Negele** has been named division engineer of appropriations and properties of the Wire Company, succeeding Mr. Lorig.

Born in St. Paul, Minnesota, Mr. Lorig's first experience with American Steel and Wire was in September 1915, when he was hired as a draftsman in the construction engineer's office. From February 1942 to April 1945, Mr. Lorig was company engineer on a government project in Duluth. Since that time he has held the position which he now relinquishes. Although Cyclone Fence division's main office is in Waukegan, Illinois, Mr. Lorig will remain in Cleveland on the general engineering staff.

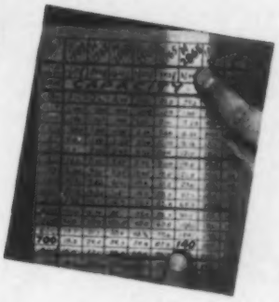
Mr. Negele is a native of Cleveland, and first started working for American Steel and Wire Company in May 1934, as a draftsman in the engineering department. Since April 1945, he has been assistant division engineer of appropriations and properties.

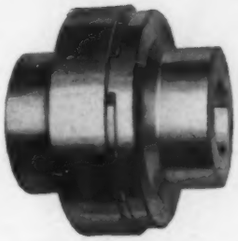
Walter H. Gilleland has been appointed assistant division superintendent of the slabbing and plate division of Homestead district works of Carnegie-Illinois Steel Corporation. Mr. Gilleland, a graduate of Bucknell University with a degree in mechanical engineering, first came to Carnegie-Illinois in 1934 as an observer in the metallurgical department at Homestead. In 1935 he was transferred to the slabbing and plate division and after several promotions became superintendent of the 30 in. slabbing mill in 1943.

In 1945 Mr. Gilleland was made assistant to the general superintendent in charge of costs, the position he is leaving to assume his new duties. He succeeds **R. W. Graham,** who has been transferred to the Geneva Steel Company, also a U. S. Steel subsidiary.

Henry H. Thomas has been appointed to the research and development staff, Pemco Corporation, Baltimore, Maryland. Mr. Thomas graduated in 1941 from North Carolina State University with a bachelor of science in ceramic engineering. Immediately following graduation Mr. Thomas volunteered for service in the United States Army. He received his initial training in California and remained there until he was ordered overseas where he served as the division ordnance officer of the 88th Infantry Division, attaining the rank of major.

Reference Guide





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Wherever heat shortens wire life . . . in factories, mills and generating plants . . . Rockbestos A.V.C. reduces costly power, control and lighting circuit maintenance by eliminating wire failures.

Insulated with heat and flame resistant impregnated asbestos these *permanently insulated* wires and cables permit continuous operation under high temperatures and other failure-creating conditions. They protect power supply, keep overloaded motors running and apparatus operating because they take heat and moisture without baking out, cracking or flowing . . . and resist the destructive attack of fumes, oil, grease and even flame.

When rewiring circuits or putting in new installations use Rockbestos A.V.C. wires, cables and cords in trouble-making locations. They will prevent wire-failures and equipment outage and save money in circuit maintenance.

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5. Remains permanently flexible
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9. Reduces circuit maintenance expense

These characteristics are built into 125 Rockbestos constructions including the wires illustrated.

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Otto J. Leone was appointed secretary, John D. Hiles Company, Inc. Mr. Leone is a specialist in instrumentation and control. He was graduated from Carnegie Institute of Technology with a bachelor of science degree in mechanical engineering. In his last position he was employed as regional manager of the steel division for the Bristol Company, for whom he worked nine years. Previously, for eight years he held a position as assistant special engineer at Homestead steel works of Carnegie-Illinois Steel Corporation, in connection with power and fuel engineering and instrument applications. He was employed by the Bacharach Industrial Instrument Company for one year.

W. H. Walter was appointed as chief mechanical engineer of American Bridge Company. He succeeds **C. G. Baumgartner** who retired after 41 years with the company.

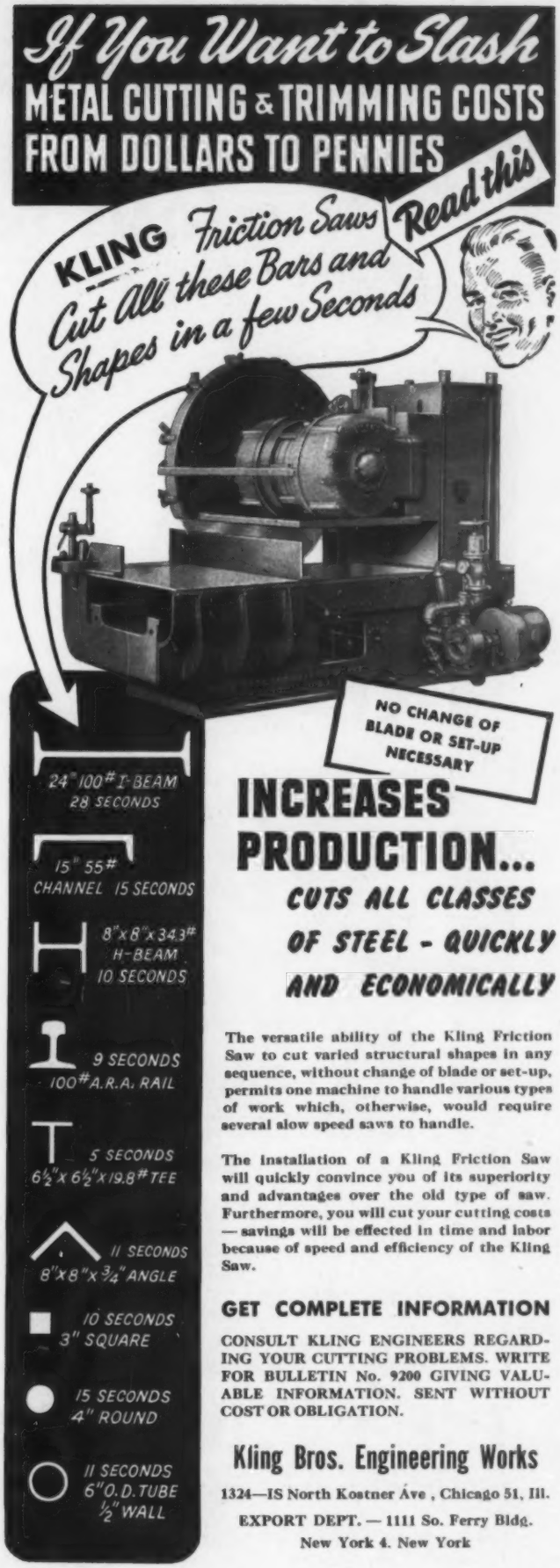
A native of Philadelphia, Mr. Walter began working during the summer months at the company's Pencoyd plant there in 1910. After graduating from Pennsylvania State College with a degree in mechanical engineering, he went with the Ambridge plant of American Bridge, where he was assigned to the Heroult electric furnace department in 1917. He served in the U. S. Navy during World War I and returned to the company in 1919. In 1937 he was made assistant mechanical engineer. Recently he was project engineer on research and development of hermetically sealed containers for the long-term storage of artillery materiel.

Birger G. Thele was appointed chief engineer, coal mines, Tennessee Coal, Iron and Railroad Company. Mr. Thele, a native of Stockholm, Sweden, received his engineering education at the Orebro Technical School in Sweden. In 1920, at the age of 21, Mr. Thele immi-

BIRGER G. THELE

grated to America and was first employed in Cleveland, Ohio, as a testing engineer and draftsman.

In January, 1922, he moved to Birmingham to join TCI, where he began his engineering career as a meter tester in the electrical engineering department. For the past six years Mr. Thele has been electrical engineer for the coal mines department.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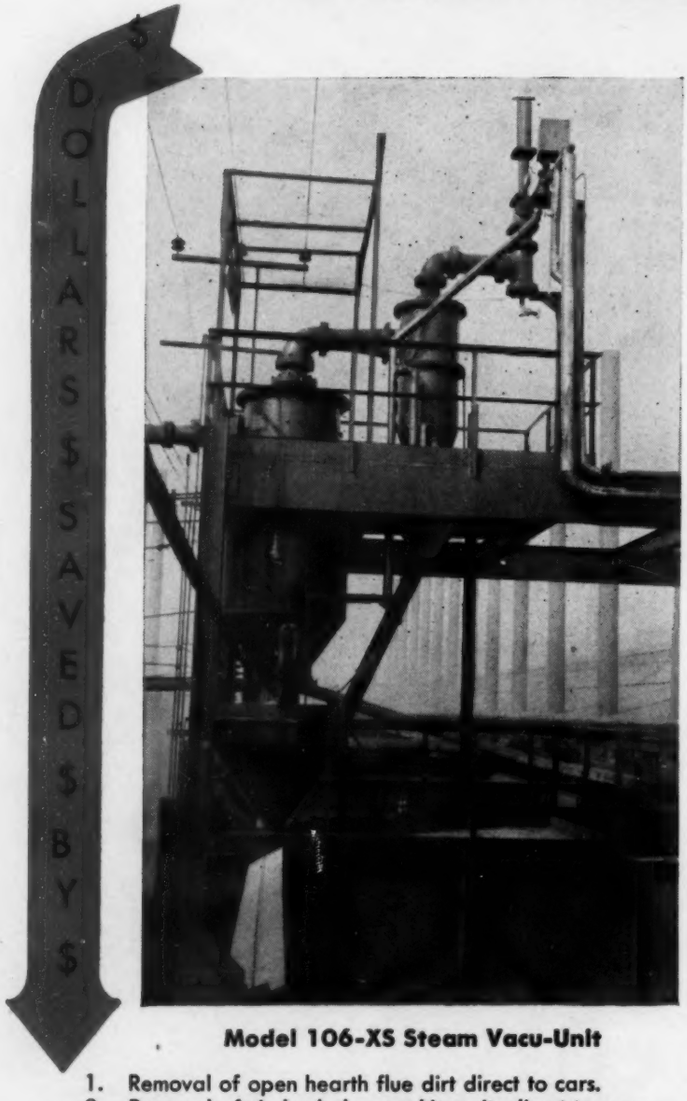

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1. Removal of open hearth flue dirt direct to cars.
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THE ASSOCIATION OF IRON AND STEEL ENGINEERS ANNOUNCES APPOINTMENT OF NEW DISTRICT SECRETARIES

J. S. MURRAY
NEW DISTRICT SECRETARY
PITTSBURGH DISTRICT SECTION

J. S. Murray has been appointed district secretary of the Pittsburgh District Section, Association of Iron and Steel Engineers. Mr. Murray recently was made Pittsburgh sales manager for the Alliance Machine Company, Alliance, Ohio. He was educated at Carnegie Institute of Technology and in the students course at Westinghouse Electric Corporation. Mr. Murray was then employed by Westinghouse in the research and sales department and in 1918 entered consulting engineering work.

In 1919, Mr. Murray was appointed field manager in charge of electrification of the Toronto, Ohio, plant of Follansbee Steel Corporation. For the next 15 years, in addition to his regular duties as electrical engineer, he supervised the production and sales of silicon electrical steels.

Mr. Murray has long been active in the Association of Iron and Steel Engineers and in 1945 served as first vice president on the Board of Directors.

MERRILL J. BOOTH
NEW DISTRICT SECRETARY
BIRMINGHAM DISTRICT SECTION

Merrill J. Booth has been appointed district secretary of the Birmingham District Section, Association of Iron and Steel Engineers. Mr. Booth succeeds **A. L. Lemon** who has served for a number of years. Born in Wells, Minnesota, in 1896, Mr. Booth was educated in the public schools of Webster, South Dakota and attended the University of Minnesota. In 1914 he was employed in electrical construction work in the electrification of southern Minnesota. In 1916, he was appointed superintendent of the western division of the Eastern Minnesota Power Company. After service in the United States Navy during World War I, he performed electrical construction work for several large concerns. In 1926, he became affiliated with the Crouse-Hinds Company, Syracuse, New York, and was transferred to the southeastern district as manager for Crouse-Hinds with headquarters at Birmingham, Alabama.

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DRAFTSMAN — EXPERIENCED DESIGN AND CHECKING STEEL MILL AND HEAVY MACHINERY

WEAN ENGINEERING CO., WARREN, OHIO

WANTED

GAG STRAIGHTENING PRESS

Similar to Sutton No. 2 Single Head Horizontal, capacity 12″ x 2″ flats, 7½″ squares, 8½″ rounds. Write giving full details. Firth Sterling Steel Company, McKeesport, Pa.

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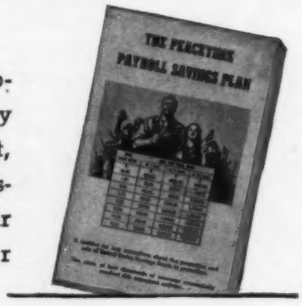
A booklet, published for key executives by the Treasury Department, containing helpful suggestions on the conduct of your payroll savings plan for U.S. Savings Bonds.



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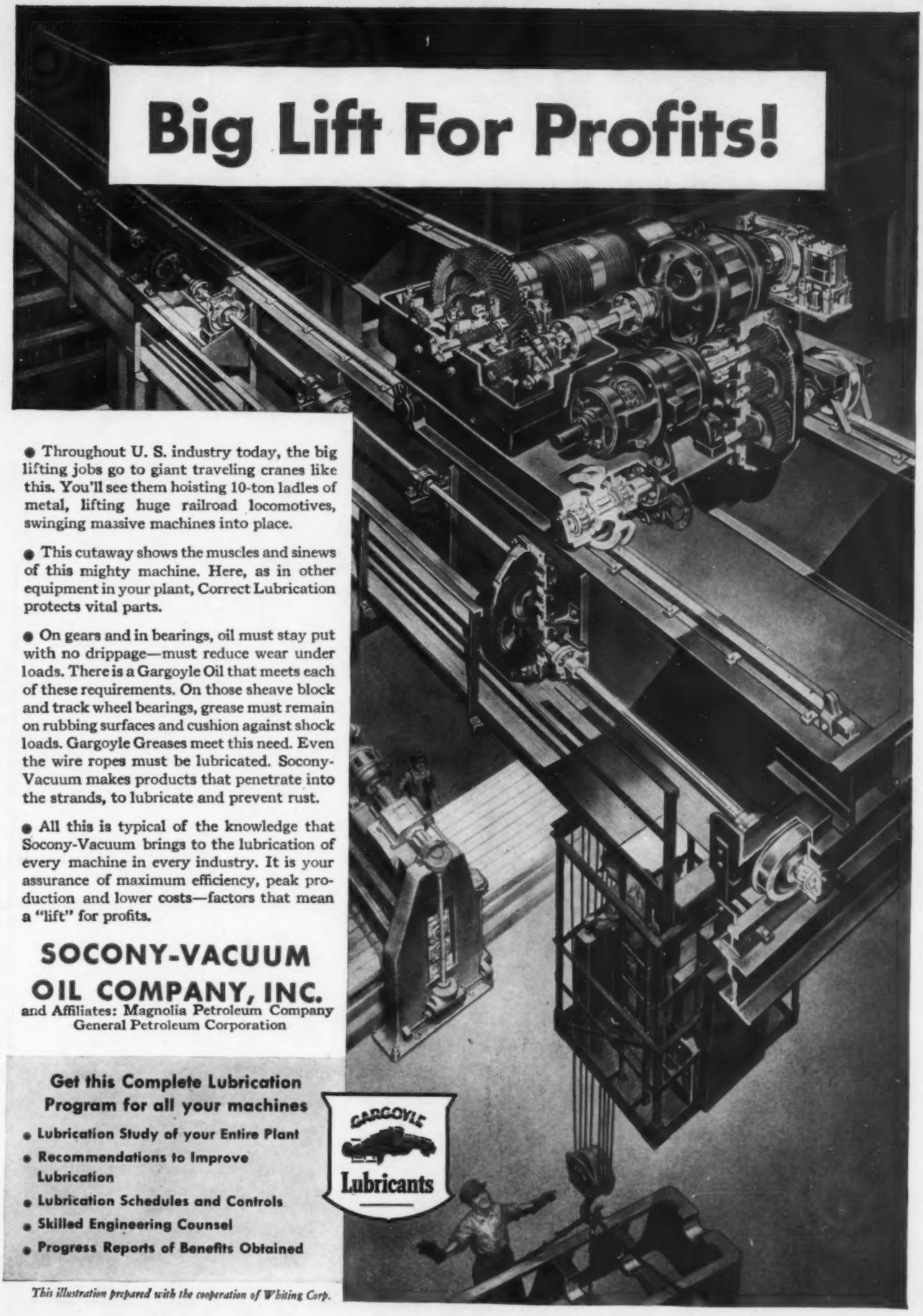

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These rugged Forced and Induced Draft Fans are built to take the battering work of boiler draft for **years** without costly time-outs for maintenance. Plates and blades are extra-heavy gauge, hot-riveted for greater strength . . . and housings exceptionally rugged. When finally it's time for replacements, all parts are readily accessible and easily removed.

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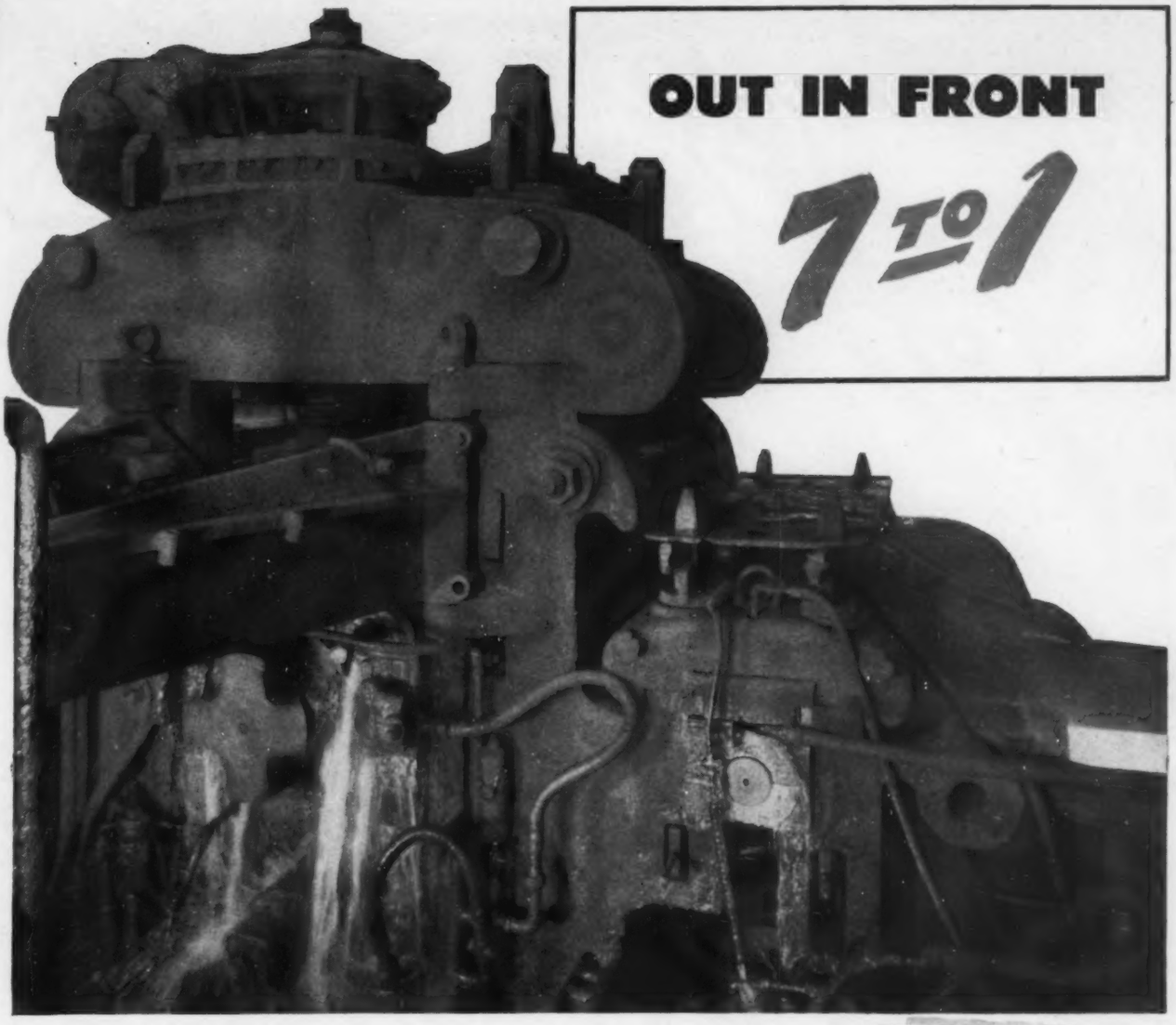

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7 TO 1

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The plug mill shown above rolls a 14-inch seamless tube and is located at the Aliquippe Works of the Jones & Laughlin Steel Corporation, Aliquippe, Pa.

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Noticeable power savings have been recorded. These result from the low coefficient of friction which is characteristic of G-E Textolite bearings with water lubrication. Then, too, no longer is it necessary to contend with fire-cracked roll-necks. And most important of all, these G-E Textolite roll-neck bearings are wearing seven times longer than the metallics formerly used—saving on replacement costs and time-consuming shut-downs for bearing maintenance.

Our experienced bearing engineers are ready to help you with your particular bearing applications. They'll work with you to give your mills the many saving features which G-E Textolite roll-neck bearings have to offer. Write to Section W-5, General Electric Company, Plastics Divisions, Chemical Department, One Plastics Avenue, Pittsfield, Mass.

GENERAL ELECTRIC

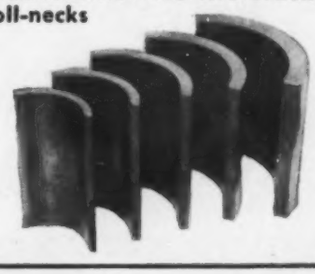
CD46-C5

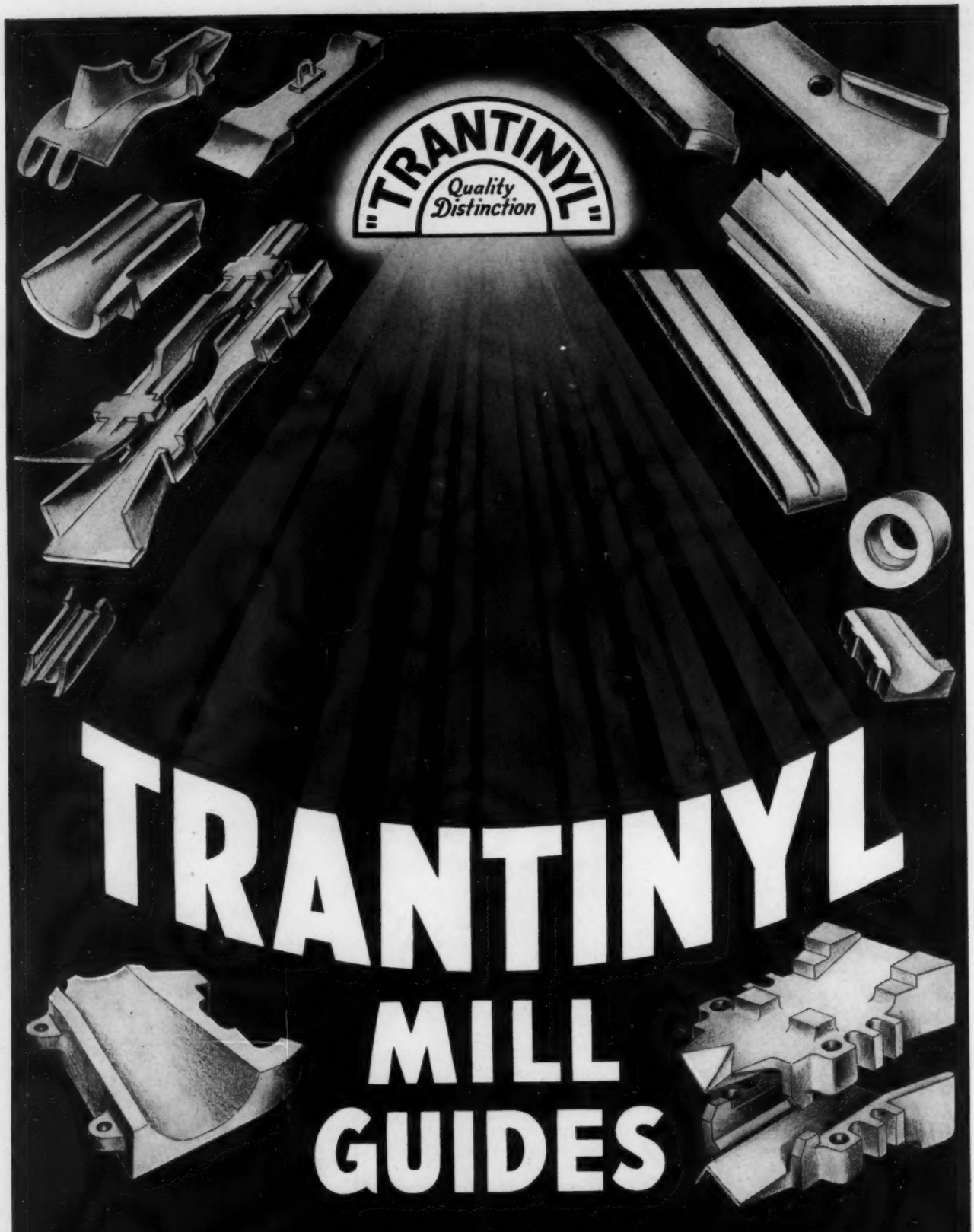
JONES AND LAUGHLIN

CASE HISTORY NO. 3

Save with **TEXTOLITE**

Maximum production • Long Life • Low-power consumption • Low grease bills • No fire-cracked roll-necks




TRANTINYL
Quality Distinction
TRANTINYL
MILL
GUIDES
YOUNGSTOWN ALLOY CASTING CORPORATION
Youngstown, Ohio

(*Continued from page 150*)

when the motors were reversed on the blooming mill. This peak load was only of a few seconds duration, but the average load on the generators during the operation of the mill was much in excess of the rated 2400 amperes. At the period of the peak load the brushes sparked quite viciously and as a result the commutator was badly burned and necessitated frequent turning of the commutator.

Early in 1946 it was discovered that there remained only $\frac{7}{32}$ of an inch of copper on the commutators. New commutators had to be ordered. However, with the present day shortages, delivery of the new commutators was uncertain. A carbon brush engineer was called in to see if a grade of brush could be obtained that would prolong the life of the commutator until new ones could be obtained.

An electro-graphitic grade was decided upon and an installation made on one generator. The familiar split type brush was also decided upon, that is two brushes were in each holder. The brush holder required a brush 3¾ in. long, 1¼ in. wide, ¾ in. thick. The split brush was of course ⅜ in. thick. This gave a carbon area of 56 square inches to carry the current load of the generator of 2400 amperes, this gave approximately 42 amperes per square inch. At the peak load of 12,000 amperes the brushes had to carry a current in excess of 200 amperes per square inch, which was a severe strain on both the brushes and the shunt connections. The rated capacity of the brushes as 60 amperes per square inch. Evidently the carbon manufacturer had underrated the current carrying capacity of this brush grade. This peak overload occurring in cycles from a few seconds to 4 or 5 minutes, the average current density the brush was required to carry was several times its rated normal capacity. Within a few hours after the brushes were installed the commutator took on the desirable dark chocolate polish and after several months operation there is no indication of burning or pitting of the bars. While the brushes have not been in operation long enough to get any idea of brush life or wear on the commutator, the indications are that the commutators will last until replacements can be made. Previous commutator dressing and change of brushes would result in good commutation for 5 to 6 months before burning was noticed.

Coils of steel-cored, copper-covered wire being placed in "hold" storage in yard of Copperweld Steel Company, Glassport, Pennsylvania, by storage battery-powered highlift, platform truck, one of fleet of eight such powered trucks that do bulk of material handling at this plant. Skid, on which coils are carried, is of special design, to permit vertical stacking.

——E-68——

NEW GEARLESS PUMP FOR TROUBLE-FREE PUMPING

▲ A new double-impeller gearless pump, with standard one-inch connections and a built-in external driveshaft bearing and base, has been developed for the circulation of water, light oil, and other liquids by ECC Engineering Company.

Designed to eliminate the most common causes of pump failure, gear jamming and stripping, this pump employs double-impellers made of several layers of a pressure-vulcanized, laminated material, and can pump equally well in either direction.

The built-in driveshaft bearing and base eliminates side-pull when the pump is powered by a belt-drive and pulley, and rules out the necessity of constructing and installing an improvised bearing. In addition, it furnishes a solid base on which to mount the pump.

Whether used with a belt-drive and pulley or with a head-on coupling, the bearing will reduce wear caused by unnecessary vibration. Tests show that the long life of the impellers has been increased considerably when the bearing is used. These impellers pass sand, grit, filings, or sludge without stalling, jamming, or stripping and without damage to the bronze pump body, and are easily replaced when the six-screw face-plate is removed.

The overall dimensions of the new double impeller model, with standard one-inch connections and built-in driveshaft bearing and base are 10½ in. × 4¼ in. × 5¾ in. Its capacity varies from 7.5 gallons per minute at 600 rpm to 23 gallons per minute at 1800 rpm.

——E-69——

TRANSPARENT CUTTING OIL PERMITS SPEEDY CUTTING

▲ Development of a new series of transparent cutting oils, pale in color, pleasant of odor and non-corrosive for use in high-temperature machining of metals, is announced by the Texas Company. Known as "Cleartex" cutting oils, A, A-1, B, DD and "Britex" cutting oil B, these products now contain certain war restricted ingredients which greatly improve their color and performance.

All oils in the series contain a combination of sulphur and chlorine, permitting high cutting speeds without corrosion of metals. Addition of the new ingredients makes possible even higher speeds in machining without the danger of corroding finished or semifinished metals, particularly nonferrous metals such as brass and copper. The color of the new oils equals pale neutral oils of the same viscosity.

Cutting characteristics of all the oils are thus improved permitting higher cutting speed, longer tool life and better surface finish.

STEEL
NEWS OF INDUSTRY
New Factors Complicate Scrap Supply Problem
New York
• • • Factors that last week gave some scrap market observers reason to feel that the worst had passed have since been overshadowed by subsequent developments. Overall gains in industrial output, indications that July employment had hit a new 60 million
definite improvement
SCRAP
Scrap Shortage Threatens Sharp Steelmaking Cut
Some production already being lost as supplies are withheld from market. Receipts only 35 per cent of needs
SHARP reduction in steel mill operations within the next few weeks as result of a serious reduction in the movement of scrap to mills is expected by steel producers.
Already some steel production is being lost because of the acute shortage
Ships damaged in the war or declared overage or surplus are providing some scrap for steel mills. Above are shown parts of a wrecked aircraft carrier in the Bethlehem, Pa., yard of Bethlehem Steel Co.
Scrap Shortage Chief Obstacle to Steel's Recovery
Request for higher price ceilings refused by OPA. Mills have less than half normal inventories. Resumption of adequate flow must await higher operations in metalworking plants. Ingot production recover
to 75 per cent
SHORTAGE of
now constitutes
the steel in

BILLETEER-equipped mills suffer less from scrap shortages

Scrap shortages work less hardship on mills which condition steel the Billeteer way.

Instead of "burning up" valuable scrap, Bonnot Billeteers thriftily save every ounce of steel removed from billets . . . classified according to analysis . . . ready for the charging box. No other cleaning method permits salvage of scrap.

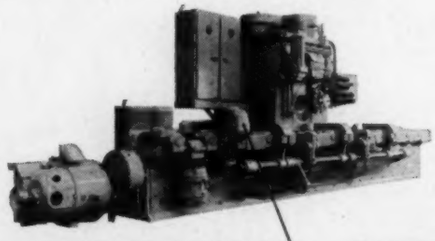
One mill, operating four Billeteers, saves over six tons of scrap a day, more than 2000 tons a year. What's more, it is often able to salvage billets so badly seamed that hand-chipping or flame-conditioning would be impractical.

In addition, it enjoys other important advantages

FOR INSTANCE: One man with a Billeteer does the work of ten manual chippers . . . does it neater and better . . . releases men for less-killing, more-profitable work.

The Billeteer never tires . . . never gets groggy . . . never has off days. Operations go along on an even keel.

Learn how the Billeteer can ease future scrap shortages for you while helping to cut your other billetshed costs. **Write.**



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FOR LOWER OPERATING COSTS

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• Bonnot Billet Inspection Tables • Charging Tables • Cold Saws Grinding Pans • Clay Mixers • Clay Feeders, Etc. •

TIMKEN BEARING EQUIPPED

The Right Tools for the Job...

Experience and research on every type of pipe and tube cleaning job have combined in the development of the special equipment used by Pittsburgh Pipe Cleaner Company. Proper tools are essential in achieving successful pipe cleaning results . . . and Pittsburgh Pipe Cleaner Company has them.

You may rest assured that when you employ Pittsburgh Pipe Cleaner Company's contract pipe cleaning service for your hearth jackets, circle pipes, waste water lines, water mains, gas mains and sewers, you benefit by the most efficient equipment that pipe-cleaning know-how has yet designed. Your water, gas and drainage systems are thoroughly cleaned, and restored to maximum efficiency . . . economically and quickly.

Let us show you how you can save your plant money and increase production efficiency through our contract pipe cleaning service. Just call or write our office nearest to you.

PITTSBURGH PIPE CLEANER COMPANY

133 DAHLEM ST. :-: PITTSBURGH 6, PA.

The hydraulic cleaning tool shown above is one of many specially designed tools that have enabled Pittsburgh Pipe Cleaner Company to successfully accomplish every type of pipe cleaning job. Our engineers will be glad to consult with you on your pipe cleaning problems. There's no obligation, of course.

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"TODAY'S unprecedented need for peacetime goods is a challenge to American industry. More things must be produced faster, better and at lower prices. Wherever ferrous metals are handled—whether scrap or finished products—the job can be done faster, better, safer and at lower costs with Ohio 'Extra Strength' Lifting Magnets. Ohio engineers are experts in the solution of metal handling problems. If you need advice on the moving of iron or steel in any form, do not hesitate to send your problem to The Ohio Electric Manufacturing Co. No obligation of course."

CHESTER BLAND, Pres.

'Application Proved'...

- Lifting Magnets
- Separation Magnets
- Magnet Controllers
- Weatherproof Connectors
- Fractional Horsepower Motors

THE OHIO ELECTRIC MFG. CO.

5807 MAURICE AVENUE, CLEVELAND 4, OHIO

BOOK REVIEW

▲ A new book just published by the Chemical Publishing Company, Inc., 26 Court Street, Brooklyn 2, New York, is "Steam Trapping and Air Venting" by L. G. Northcroft. The book consists of 172 pages, 216 illustrations and costs $4.60. Although steam traps are regarded by many engineers as an unnecessary evil, their correct use is a sure means of obtaining economy, and increased production. This book is a complete reference on methods of steam trapping and air venting. Operators and managers of steam heat plants will find much valuable information in the book.

▲ Carbon, one of the essential ingredients of steel, is used in many ways in the steel industry. A new edition of "Industrial Carbon" by C. L. Mantell, may be obtained from the publisher, D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, for $7.50. The book is a complete treatise on the use of carbon in industry as well as a reference work on its manufacture and the effect of various manufacturing processes on its properties. Of particular value to the steel man are the chapters on electrodes, brushes, refractories, and carbon as a material of construction.

▲ Probably one of the most complete and scholarly works on the subject of gear teeth has been computed and compiled by Warner F. Vogel, Dr.Eng., and Associate Professor of Engineering at Wayne University. It is entitled "Involutometry and Trigonometry." The book is sold by the Michigan Tool Company, Detroit, Michigan. One of the most valuable sections are the seven place tables of natural functions, which have been developed for every 100th of a degree of the 90 degree quadrant. The book was written primarily for the gear designer but will serve as a valuable reference book for any one else who must work with gears.

ASSISTANT SALES ENGINEER . . . . With technical knowledge of rolling mill operations and equipment. Must be experienced in purchasing used machinery. Write stating experience, background, salary wanted, etc. All replies confidential. Address Box T 46, 1010 Empire Building, Pittsburgh 22, Pa.

Weigh ALL the facts

before you buy Insulating Firebrick

Properties of the Johns-Manville Brick and Fireblok Insulation Line

PROPERTIES	INSULATING BRICK			INSULATING FIREBRICK AND FIREBLOK			
	Sil-O-Cel Natural	Sil-O-Cel C-22	Sil-O-Cel Super	JM-1620	JM-20	JM-23	JM-26
Density—lb. per cu. ft.	30	38	40	29	35	42	48
Transverse Strength—lb. per sq. in.	140	115	90	60	80	120	125
Cold Crushing Strength—lb. per sq. in.	400	700	300	70	115	170	190
Linear Shrinkage—Percent	1.4 @ 1600F	0.8 @ 2000F	2.0 @ 2500F	0.0 @ 2000F	0.0 @ 2000F	0.3 @ 2300F	1.0 @ 2600F
Reversible Thermal Expansion—Percent	0.1 @ 1600F	0.7 @ 2000F	1.3 @ 2000F	0.5—0.6 @ 2000F	0.5—0.6 @ 2000F	0.5—0.6 @ 2000F	0.5—0.6 @ 2000F
Conductivity at Mean Temperature	∥ ⊥						
500F	1.01 .67	1.67	1.70	.77	.97	1.51	1.92
1000F	1.13 .79	1.88	1.95	1.02	1.22	1.91	2.22
1500F	1.24 .90	2.08	2.19	1.27	1.47	2.31	2.52
2000F	— —	—	2.45	—	1.72	2.70	2.82
Recommended Service							
Back Up	1600F	2000F	2500F	2000F	2000F	2300F	2600F
Exposed	—	—	—	1600F	2000F	2300F	2600F
Recommended Mortar for Setting Brick	Sil-O-Cel Mortar	Sil-O-Cel Mortar	Sil-O-Cel Super Brick Mortar	J-M No. 1626 Cement	J-M No. 1626 Cement	J-M No. 1626 Cement	J-M No. 1626 Cement

Note: 1. Above tests are in accordance with ASTM tentative standards.
2. Conductivity is expressed in Btu in. per hr per sq ft per deg F at the designated mean temperatures.
3. ∥ —with heat flow parallel to brick strata.
⊥ —with heat flow perpendicular to brick strata.

In Insulating Firebrick, it's the correct BALANCE of thermal and physical PROPERTIES THAT COUNTS!

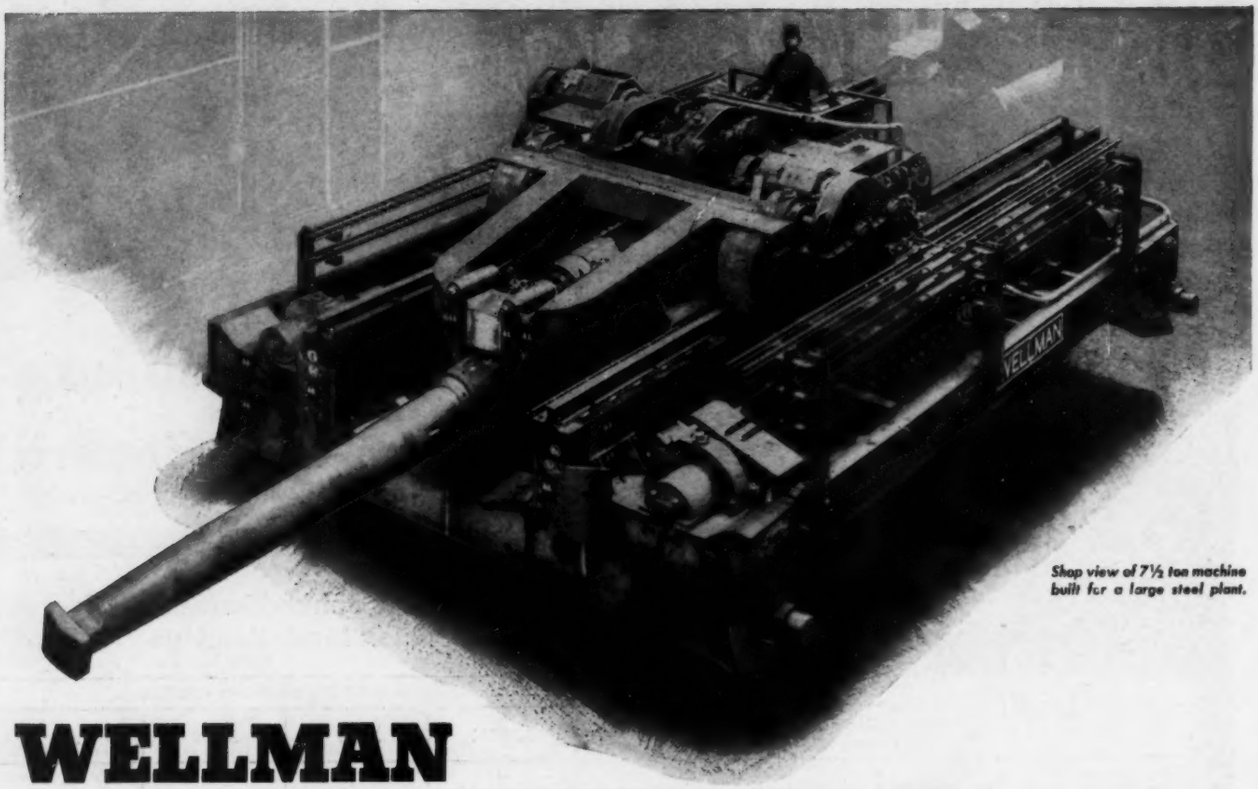
AS THE CHART SHOWS YOU—each of the seven types of J-M Insulating Brick and Insulating Firebrick is designed to do a special job . . . and do it well!

The three J-M Insulating Brick provide great structural strength, the four J-M Insulating Firebrick combine strength with exceptional resistance to spalling. All seven offer the advantages of light weight and low conductivity. They are recommended as back-up insulation or insulating firebrick for all industrial requirements.

For all the facts, write Johns-Manville, Box 290, N. Y. 16, N. Y.

JM PRODUCTS

Johns-Manville *First in* Insulations

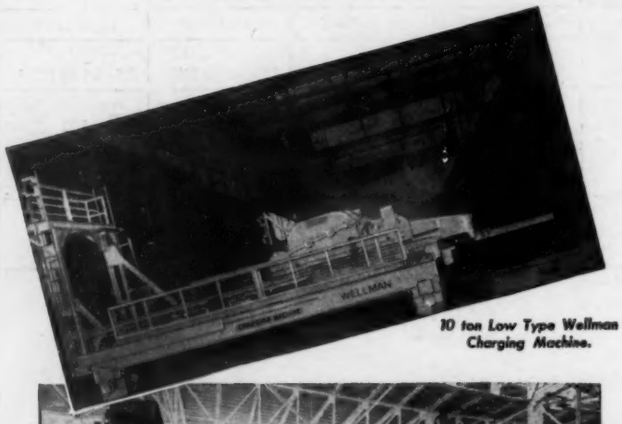


Shop view of 7½ ton machine built for a large steel plant.

WELLMAN

MANUFACTURES THE MOST COMPLETE LINE OF

CHARGING MACHINES



10 ton Low Type Wellman Charging Machine.

5 ton High Type Wellman Charging Machine.

Wellman originated the labor saving, mechanical charging of open hearth furnaces and now makes most complete line of improved, modern chargers. Some features: one-piece furnace annealed cast steel trolley frame . . . air tight gear cases . . . modern roller bearing design (optional) . . . bridge framework with main and auxiliary girders. Wellman makes Low Type (5, 7½, 10 and 12 ton) High Type (5 ton) Crane and Revolving Types, also charging machines for heating furnaces, and manipulators for forging presses and hammers.

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Car Dumpers • Coke Pushers
Clamshell Ore Buckets
Ore Bridges • Mine Hoists
Gas Producers • Soaking Pits
Skip Hoists • Wharf Cranes

THE WELLMAN ENGINEERING COMPANY

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The use of De Laval double reduction worm gears for operating the screw-downs on this Farrel-Birmingham sheet rubber calender illustrates the extreme compactness of this type of drive for transmitting high torques at high reduction ratios. Each screw-down is adjusted by means of a separate motor and reducer unit, making it possible either to adjust each end of each roll independently or to synchronize the adjustment of both ends in parallel.

1153

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WORM GEAR DIVISION
DE LAVAL
STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

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SWINDELL-DRESSLER *Corporation*

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IN HYDRAULIC SYSTEMS

To protect your hydraulic systems effectively against costly work stoppages — to keep them operating more smoothly and dependably—use an oil that prevents sludge and rust — *Texaco Regal Oil (R & O).*

Texaco Regal Oils (R & O) come in a complete range of viscosities . . . to serve the largest to the smallest hydraulic units. These oils free themselves rapidly of air and water . . . prevent oxidation (the cause of sludge) and foaming. They "plate" internal metal parts against rust-forming moisture, and stand up under high temperatures and agitation. They lubricate effectively and transmit power smoothly.

Leading makers of hydraulic equipment ship their units filled with *Texaco Regal Oils (R & O)* or recommend their use . . . substantial evidence that you can depend on them to assure trouble-free, economical performance.

For full information, call the nearest of the more than 2300 Texaco distributing plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

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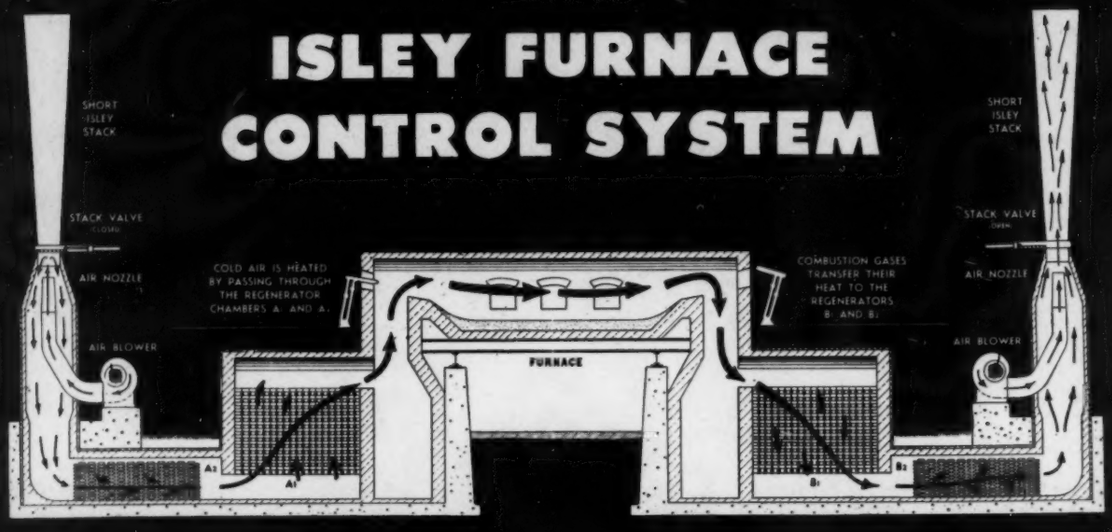
TEXACO Regal Oils (R&O)

FOR ALL HYDRAULIC UNITS

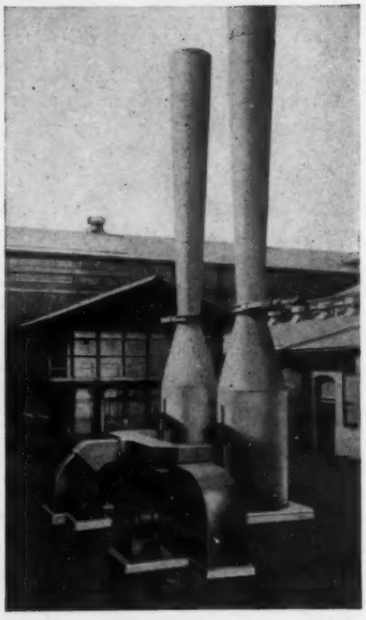
TUNE IN THE TEXACO STAR THEATRE WITH JAMES MELTON EVERY SUNDAY NIGHT—CBS

8 distinct advantages of the ISLEY FURNACE CONTROL SYSTEM



1. Up to 50% more regenerative capacity . . . more effective and more economical control of combustion in all types of regenerative furnaces.
2. Substantial savings in initial cost, installation time and space requirements.
3. Cost of changing from old-fashioned system to Isley System will amortize the reasonable cost in a short time by savings of fuel and maintenance, increased production and more uniform quality.
4. Better use of heat . . . assuring lower fuel consumption.
5. Better combustion, due to higher air temperatures—permits shorter heats, more heats per campaign . . . means *higher production* at a *better profit!*
6. Constant, measured flow of air, with complete independence of stack and atmospheric conditions.
7. No water-cooled reversing valves to maintain—no freezing of valves and lines.
8. The Isley Furnace System can be operated automatically.

At present more than 200 Regenerative Furnaces . . . in this country and abroad . . . are using the Isley Furnace Control System.



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ISLEY *Positive* Control

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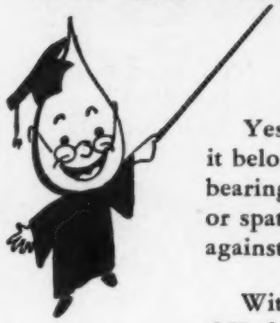
TRADE MARK REGISTERED IN U.S. PAT. OFFICE & FOREIGN COUNTRIES

NON-FLUID OIL

MEANS MORE THAN JUST PLAIN LUBRICATION



Yes, NON-FLUID OIL does more than just lubricate. It stays put — where it belongs — because it is so highly adhesive that it can't work out at the ends of bearings like ordinary oils. Motors keep cleaner because there is no dripping or spattering and need re-oiling one-third as often. Positive protection is assured against burned out windings so often caused by oil-soaked insulations.

With NON-FLUID OIL, you get no oil spots on sheets because NON-FLUID OIL does not drip and leak like ordinary liquid oil. In pickling and galvanizing alone — as sheet and tin plate men everywhere will tell you — this means savings on spoiled sheets in one month amounting to more than a whole year's lubrication costs!

What's more — used to replace grease, NON-FLUID OIL lubricates dependably— does not thin out at high temperatures — won't disintegrate when subjected to high pressures. Quantity for quantity, it goes three times farther than ordinary lubricants.

NON-FLUID OIL is the modern, scientific answer to perfect lubrication. It pays dividends in cutting production costs by keeping machines in steady operation at the lowest cost per finished ton. Besides, it saves on oil and grease bills.

NON-FLUID OIL is available in many grades for specific purposes. Send for free testing samples today for trial in your own plant.

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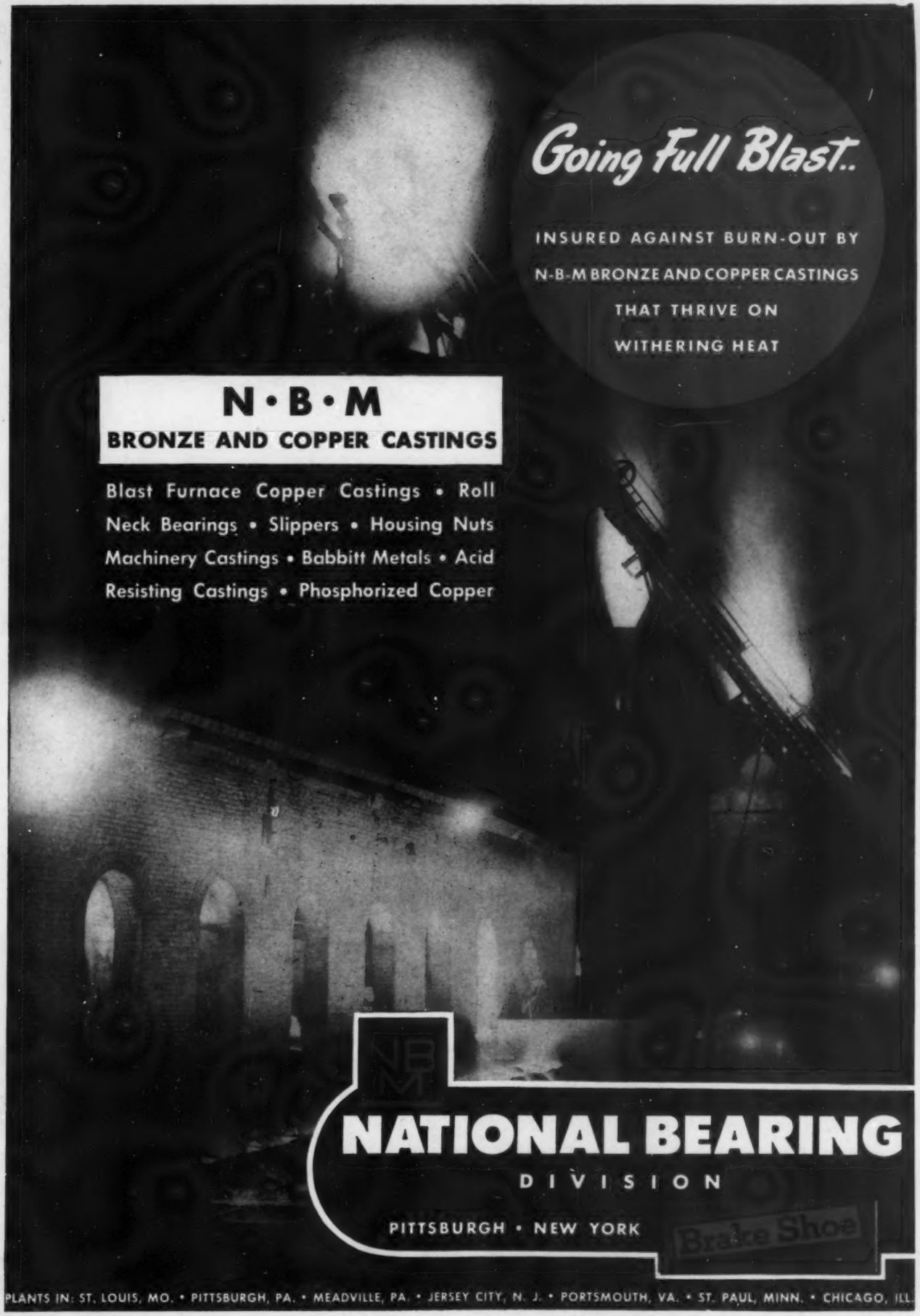
Ohio Rolls

THE OHIO STEEL FOUNDRY COMPANY
LIMA, OHIO • *Plants in Lima and Springfield, Ohio*

ENGINEERS
FOUNDERS
MACHINISTS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INSURED AGAINST BURN-OUT BY
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One Man--- One Minute...

Thats All it Takes to Bleed Wagner Hydraulic Industrial Braking Systems

Remote-control bleeding is the latest improvement in Wagner hydraulic braking systems for overhead traveling cranes and other industrial equipment. Controlled from the crane cab, the bleeder enables the operator to remove air from the fluid lines whenever necessary, simply by pressing a pushbutton and pumping the control cylinder foot pedal.

Other Advantages of the Remote-Control Bleeder:

1. One man can quickly bleed system.

2. Maximum braking efficiency is constantly maintained by keeping lines full of fluid at all times.

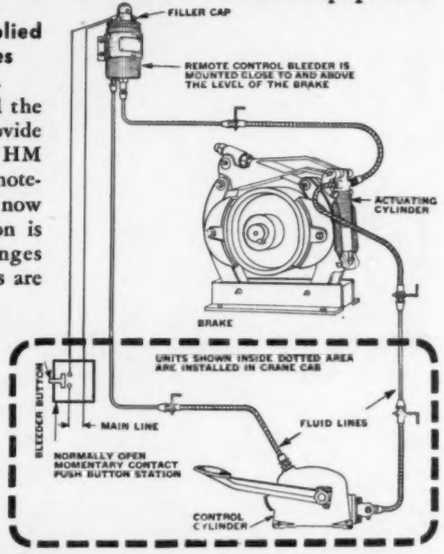
3. Circulatory bleeding results in a saving of fluid, since none is lost during the bleeding operation.

4. Brake can be installed at a considerable height above the control cylinder—an important factor in successful ladle crane applications.

All current Wagner Hydraulic crane-bridge braking systems include the remote-control bleeder as standard equipment.

Can Be Easily Applied to Wagner Brakes Now In Service.

Kits containing all the parts needed to provide type H and type HM brakes with the remote-control bleeder are now available. Installation is simple, as no changes in the basic systems are necessary.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REMOTE CONTROL BLEEDER IS MOUNTED CLOSE TO AND ABOVE THE LEVEL OF THE BRAKE
ACTUATING CYLINDER
BRAKE
UNITS SHOWN INSIDE DOTTED AREA ARE INSTALLED IN CRANE CAB
BLEEDER BUTTON
MAIN LINE
FLUID LINES
NORMALLY OPEN MOMENTARY CONTACT PUSH BUTTON STATION
CONTROL CYLINDER

In addition to these important features furnished by the remote-control bleeder, Wagner hydraulic industrial brakes offer many other advantages, discussed in Bulletin IU-186. Send for a copy today, addressing your request to Wagner Electric Corporation, 6483 Plymouth Avenue, St. Louis 14, Mo.

Consult Wagner Engineers on all Industrial Braking Problems

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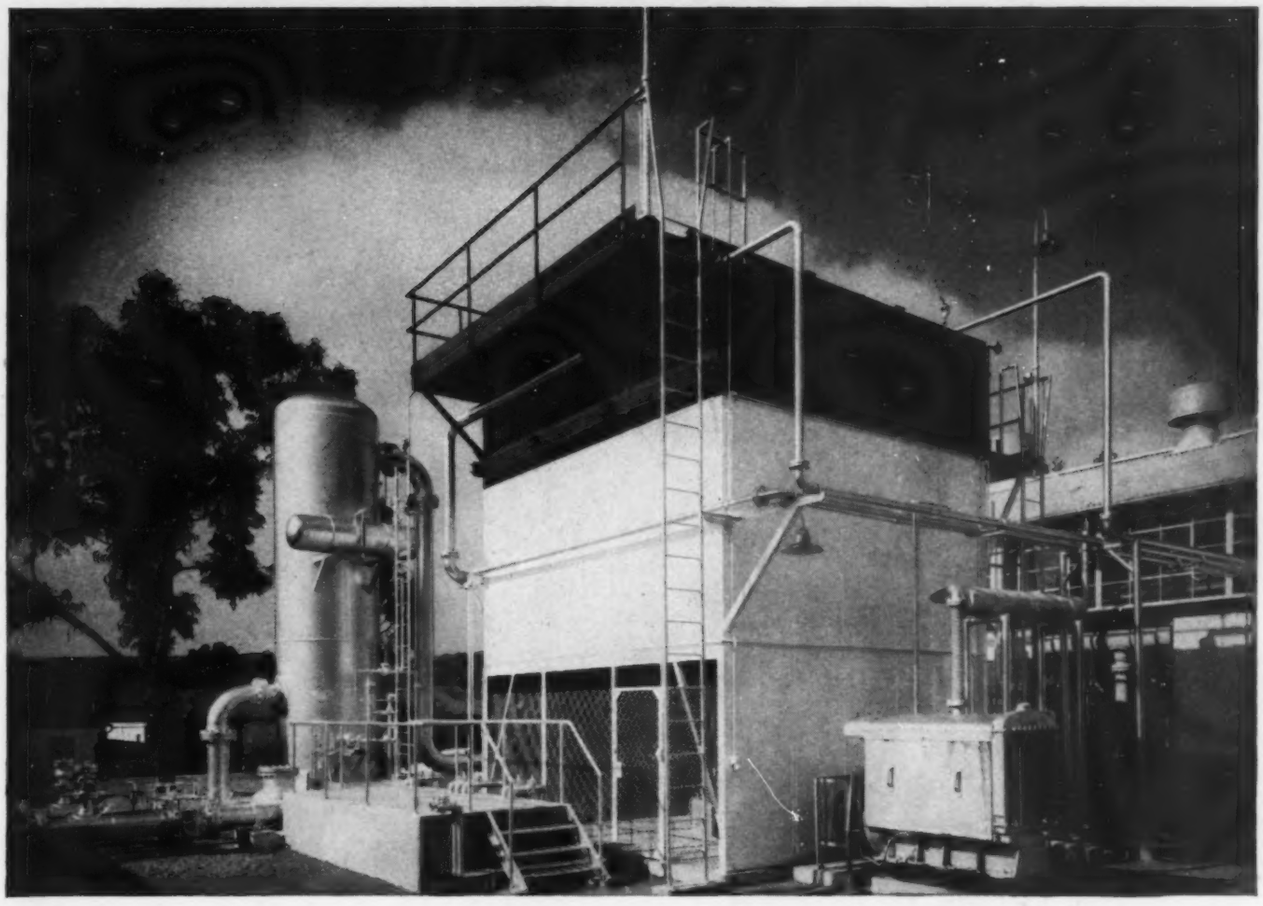

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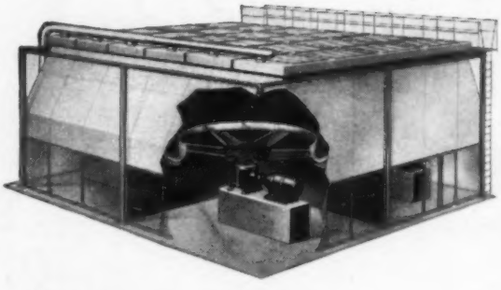

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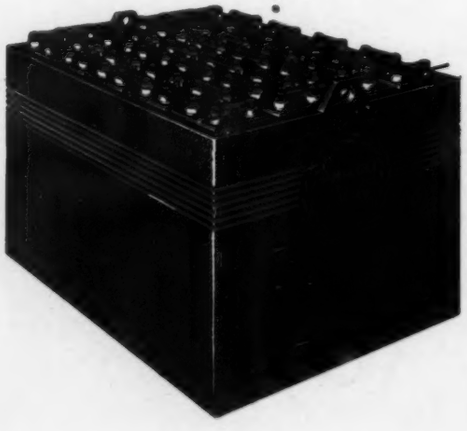

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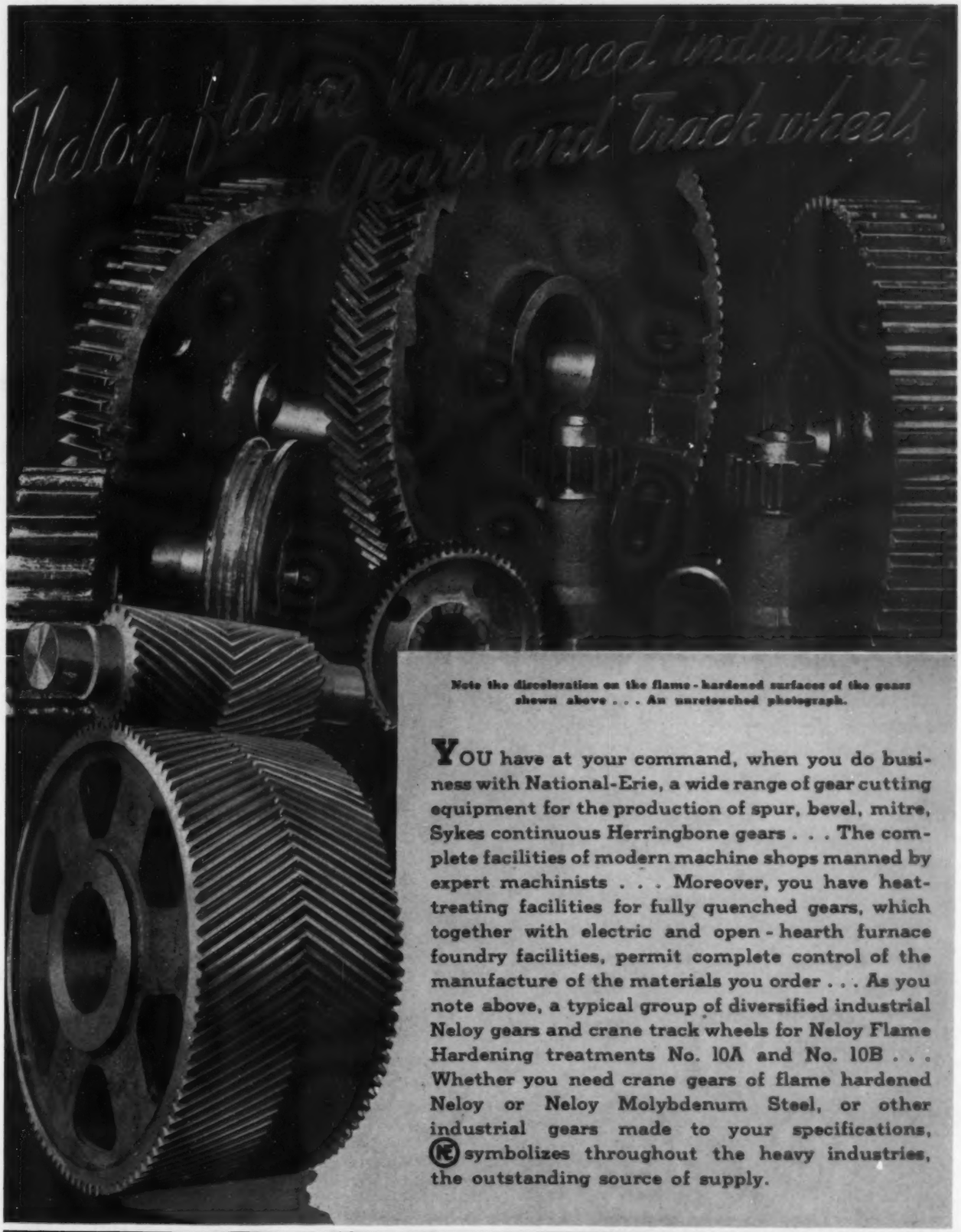

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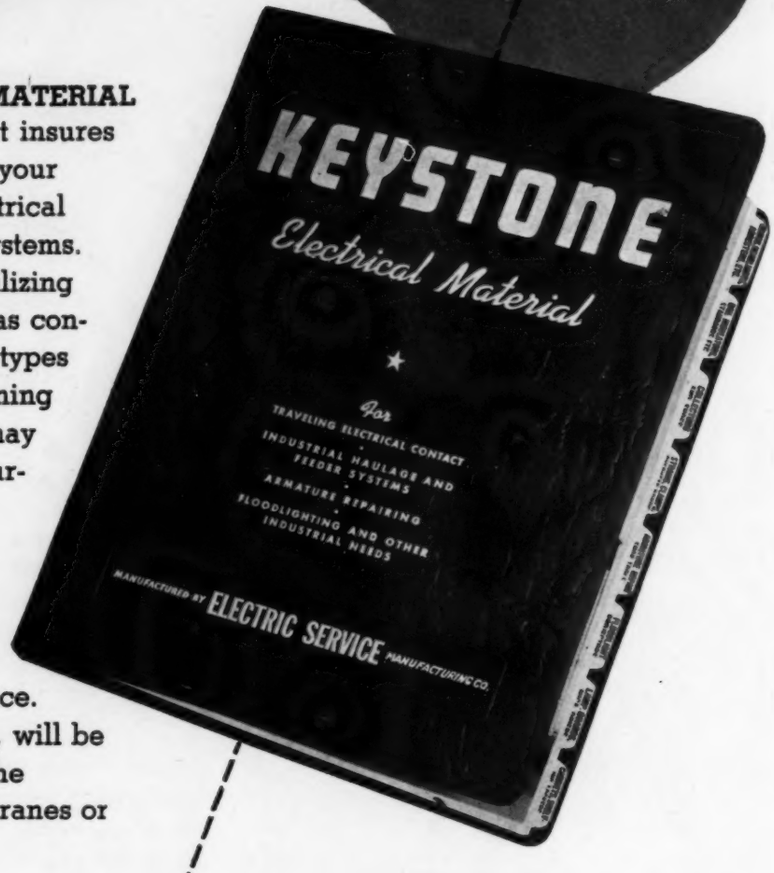

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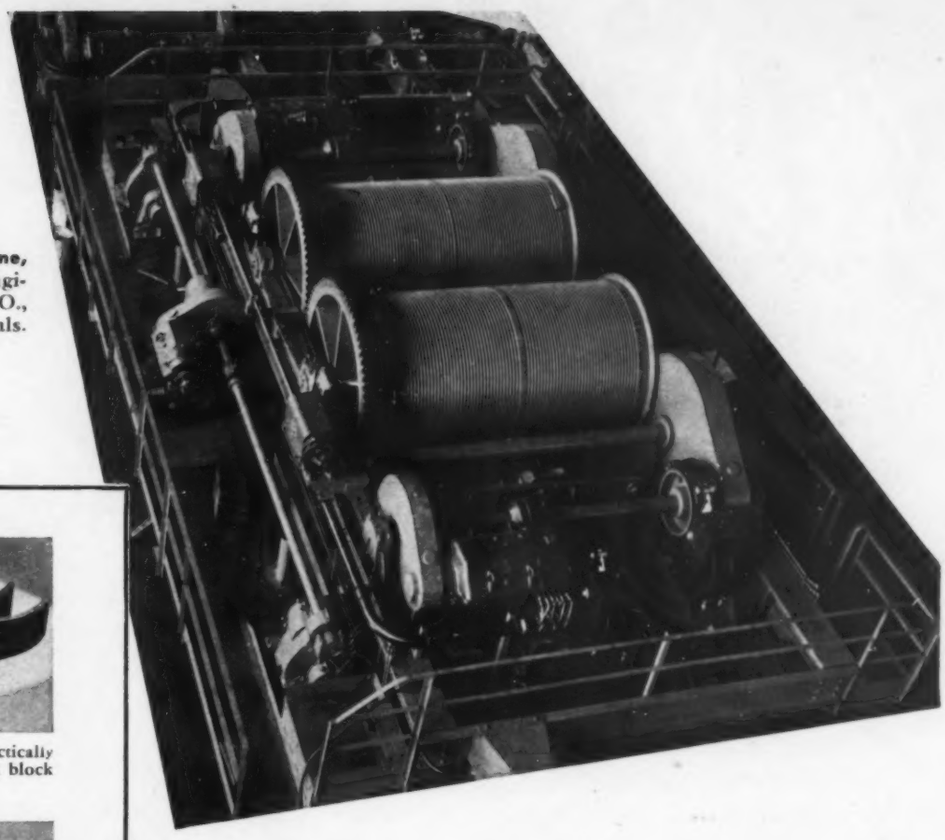

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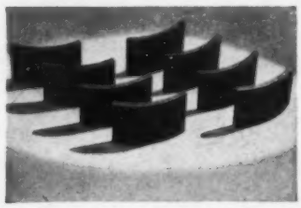

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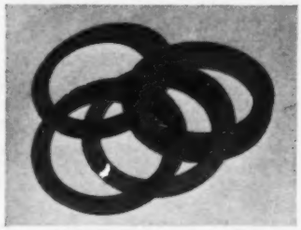

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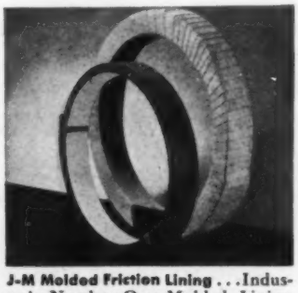

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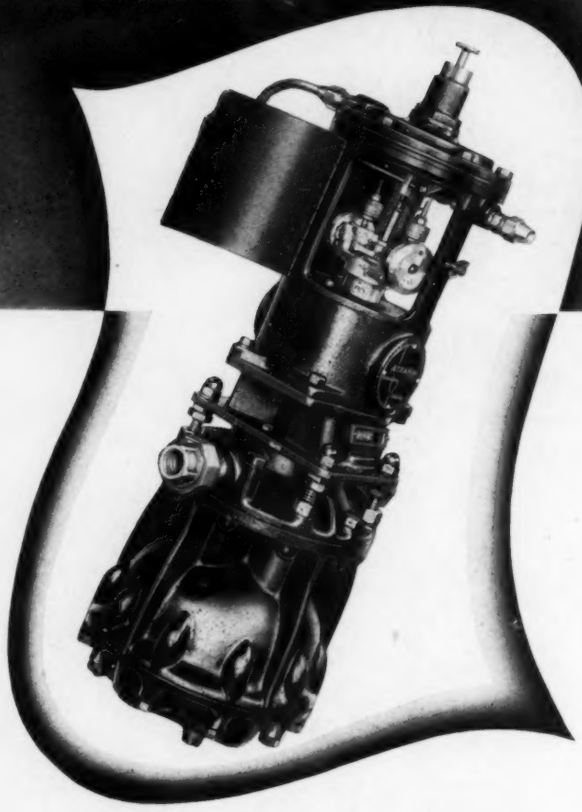

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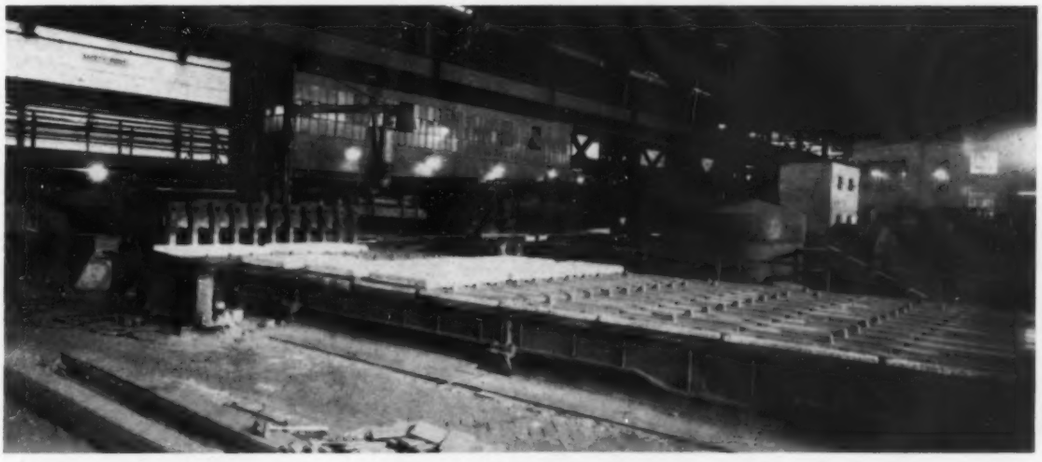

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INDEX TO ADVERTISERS

A

Aetna-Standard Engineering Company 1
Air Reduction Sales Company 51
Allen-Bradley Company 169, 170
Alliance Machine Company 5
Allis-Chalmers Manufacturing Company 7
Aluminum Company of America 22
American Hammered Piston Ring Division of Koppers Company 165
Arms-Franklin Corporation 43
Askania Regulator Company 206
Automatic Transportation Company 16

B

William M. Bailey Company 27
Bantam Bearings Division, The Torrington Company 4
Bartlett-Hayward Division of Koppers Company 165
Bedford Foundry and Machine Company 69
Birdsboro Steel Foundry and Machine Company 154, 155
Bloom Engineering Company 69
Bonnot Company 188
H. A. Brassert and Company, Limited 52
Broden Construction Company 52
Brooks Oil Company 41
Brown Instrument Company 50
Buckeye Laboratories Corporation 26
Buffalo Forge Company 184

C

Chiksan Company 147
Clark Controller Company 40
Cleveland Crane and Engineering Company 48
Continental Foundry and Machine Company 19, 20
Cutler-Hammer, Inc. ..... Cover 2

D

De Laval Steam Turbine Company 76, 193

E

Electric Controller and Manufacturing Company 15
Electric Service Manufacturing Company 204
Electric Storage Battery Company 36
Elwell-Parker Electric Company 37
Engineering and Construction Division of Koppers Company 165

F

Falcon Bronze Company 140
Farval Corporation ..... Cover 3
Flinn and Dreffin Company 52
Fluor Corporation, Limited 14, 201
Furnace Engineers, Inc. 160

G

Gas and Coke Division of Koppers Company 165
General Electric Company ..... Cover 4, 28, 29, 158, 159
General Electric Company, Plastics Division 185

H

Hallden Machine Company 52
Harbison-Walker Refractories Company 153
Heppenstall Company 17
C. B. Hunt and Son, Inc. 21
Hyatt Bearings Division, General Motors Corporation 172
Hydropress, Inc. 3

I

International Nickel Company 152

J

Johns-Manville Corporation 191, 205
W. A. Jones Foundry and Machine Company 140
Kling Bros. Engineering Works 177
Koppers Coal Company 165
Koppers Company, Inc. 165
Koppers Rheolaveur Company 165

L

Leeds and Northrup Company 18
Lewis Foundry and Machine Division, Blaw-Knox Company 11
Linde Air Products Company 30
Lovejoy Flexible Coupling Company 175

M

Mackintosh-Hemphill Company 151
Maryland Drydock Company 165
Mathews Conveyer Company 145
McKay Machine Company 52
Medart Company 150
Mesta Machine Company 8, 9
Midvale Company 42
Morgan Construction Company 25, 196
Morgan Engineering Company 157
Morganite Brush Company 168
D. J. Murray Manufacturing Company 76

N

National Bearing Division, American Brake Shoe Company 199
National Carbon Company, Inc. 156, 166
National Erie Corporation 203
National Roll and Foundry Company 2
New York and New Jersey Lubricant Company 197
Norma-Hoffmann Bearings Corporation 210
North American Manufacturing Company 182

O

Ohio Electric Manufacturing Company 190
Ohio Steel Foundry Company 198
Okonite Company 164

P

Peerless Pump Division, Food Machinery Corporation 148
Pennsylvania Engineering Works 31
Pennsylvania Transformer Company 34
Philco Corporation, Storage Battery Division 202
Pittsburgh Lectromelt Furnace Corporation 54
Pittsburgh Pipe Cleaner Company 189
Poole Foundry and Machine Company 33
Post-Glover Electric Company 24

R

Railway and Industrial Engineering Company 138
Reliance Electric and Engineering Company 161
Rockbestos Products Corporation 176
R-S Products Corporation 13
Jos. T. Ryerson and Son, Inc. 142

S

Salem Engineering Company 10
SKF Industries, Inc. 32
Speer Carbon Company 181
Socony-Vacuum Oil Company 183
Square D Company 23
Surface Combustion Corporation 162, 163
Swindell-Dressler Corporation 194

T

Tar and Chemical Division of Koppers Company 165
Texas Company 195
Tide Water Associated Oil Company 39
Timken Roller Bearing Company ..... Cover 1
Tool Steel Gear and Pinion Company 44, 45
Treadwell Engineering Corporation 207
Truflo Fan Company 149
Trumbull Electric Manufacturing Company 155

U

Union Carbide and Carbon Corporation 30, 156, 166
United Engineering and Foundry Company 6, 38

V

The Vacuum Conveyor Company 178
Valley Mould and Iron Company 141
Vaughn Machinery Company 174

W

Wagner Electric Corporation 200
John Waldron Corporation 173
Ware Brothers 35
Wapakoneta Machine Company 12
Wean Engineering Company, Inc. 52
Wean Engineering Company of Canada, Ltd. 52
Wellman Engineering Company 192
Western Gas Division of Koppers Company 165
Westinghouse Electric Corporation 46, 47
White Tar Company of New Jersey, Inc. 165
Wood Preserving Corporation 165

Y

Youngstown Alloy Casting Corporation 186

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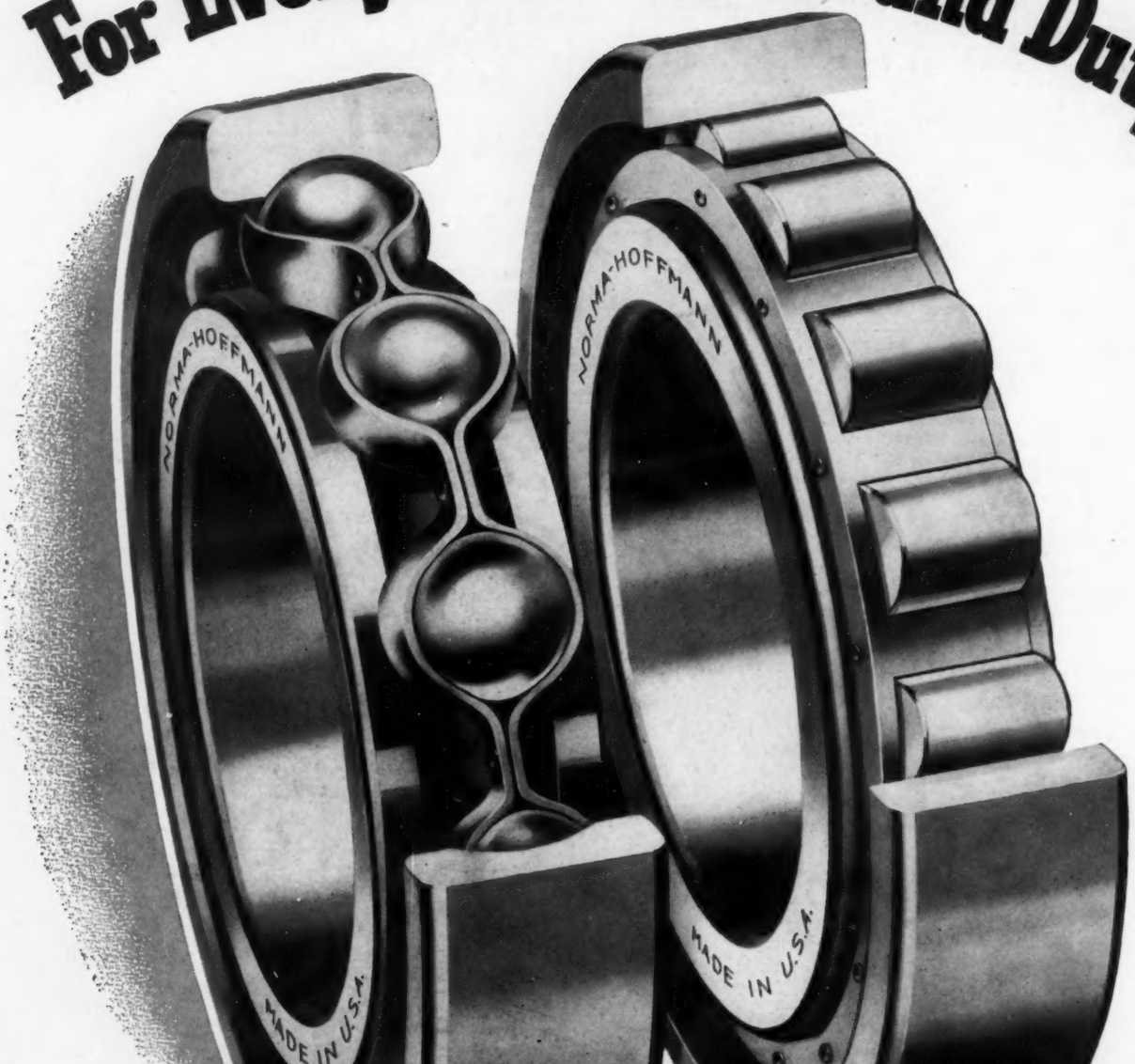

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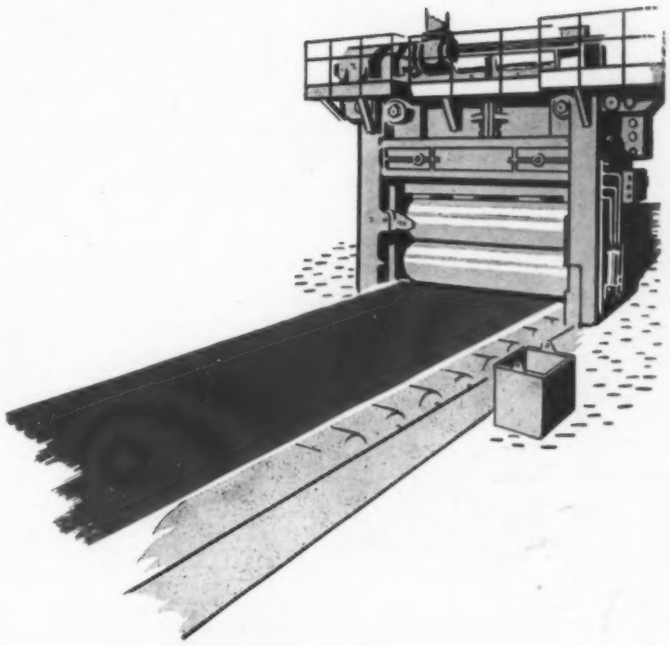

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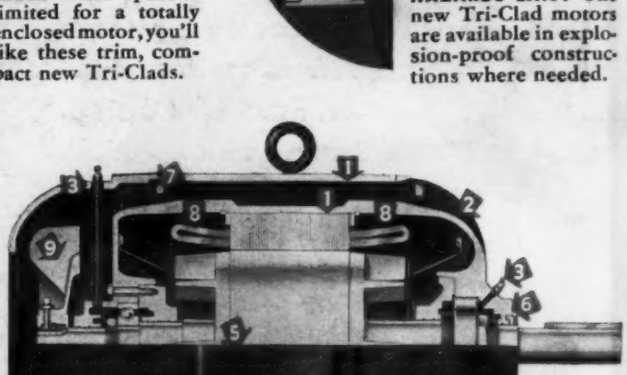

10-POINT PROTECTION

1. A cast-iron, double-wall frame completely encloses and protects the windings and punchings.
2. Corrosion-resistant cast-iron end shields are machined to provide a tight seal, and protect the motor from dust, dirt, and moisture. Primer and finish coat of Glyptal* varnish affords high rust-resistance.
3. A pressure-relief greasing system, which can be packed with long-life lubricant, protects the bearings.
4. The cast-iron conduit box is diagonally split for easy wiring. Boxes are independently explosion-proof on Class I motors.
5. Nonshrinking compound around motor leads protects motor interiors from dust and moisture at the point where leads pass through the frame.
6. Rotating labyrinth seal further protects motor interior from damage by foreign matter.
7. Large air passages provide adequate protection from overheating. They're easy to keep clean and open, too.
8. Modern, "ageless" insulation treatment includes windings of *Formex magnet wire.
9. The powerful external fan is removable to simplify maintenance; nonsparking type in explosion-proof motors.
10. Individual dynamic balance of rotors and external fans protects against vibration hazards, even under severe operating conditions.

*Trade-mark Reg. U. S. Pat. Off.

FOR THE COMPLETE STORY

Apparatus Department, Section 750-278C
General Electric Company
Schenectady 5, N. Y.

☐ Please send me GEA-4400, which describes the new Tri-Clad totally enclosed motors.

☐ Please send me GEA-4131, "Motors and Control for Hazardous Locations."

NAME .....

COMPANY .....

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GENERAL ELECTRIC